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Marketing Research Report No. 617
U. S. DEPARTMENT OF AGRICULTURE
Economic Research Service
Marketing Economics Division

FREEZE-DRIED FOODS:

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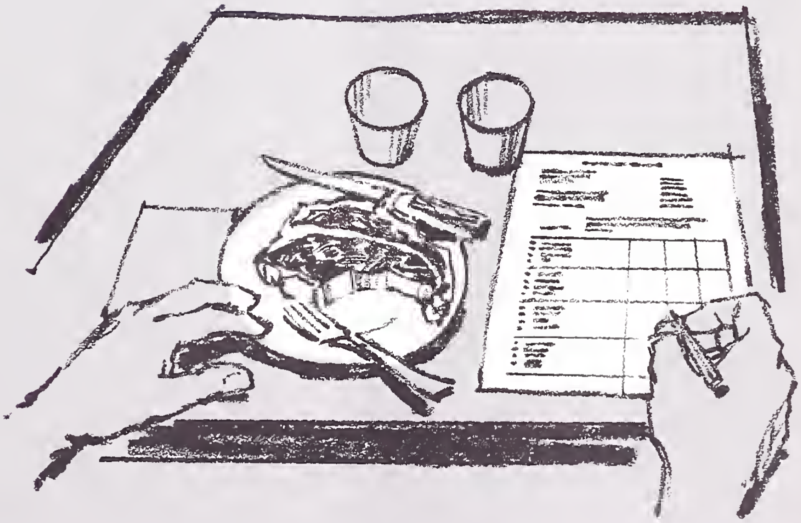

PALATABILITY TESTS

ACKNOWLEDGMENTS

Elsie H. Dawson of the Human Nutrition Research Division, Agricultural Research Service, and Philip Dwoskin, Marketing Economics Division, Economic Research Service, helped solve problems relating to experimental design. Jennie L. Brogdon, Human Nutrition Research Division, was in charge of panel tests. Kenneth McCallister of Marketing Economics Division supervised the variance analysis and tests of significance.

Others sharing their experience and understanding of taste panel work include Lendal Kotschevar of the Kellogg School of Hotel Management, Michigan State University. Those offering positive suggestions and advice on problems encountered in taste panel research include Max Brockman, Martin S. Peterson, and Herbert Fritzsche, Armed Forces Food and Container Institute, U. S. Army Quartermaster Research and Engineering Command.

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Washington, D. C. July 1963

HIGHLIGHTS

Most freeze-dried foods on the market are "acceptable" from a palatability standpoint as judged by a taste panel in the U. S. Department of Agriculture. None of the 28 freeze-dried foods evaluated received an "unacceptable" score as to palatability, and two thirds of them were as good as the processed foods with which they were compared. Palatability is rated in terms of general acceptance and the five quality characteristics: Appearance, flavor, juiciness, texture, and tenderness.

The freeze-dried items taste-tested included beef, pork, chicken, seafoods, soups, and several mixtures of foods. When compared with other processed foods, 3 of these were considered superior, 15 were about the same, and 10 were rated poorer in relation to their frozen or canned counterparts. Freeze-dried foods rating superior were beef noodle soup, chicken noodle soup, and shrimp creole. Others having commendable scores relative to the comparison foods were creamed chicken, ham, sausage, swiss steak, shellfish, and soups other than those listed above.

Freeze-dried foods used in prepared mixtures received higher scores, on the average, than the same foods served plain. The addition of other ingredients and spices in the prepared dishes appeared to mask the lack of flavor that affected palatability ratings of these foods when served alone. This was particularly evident for chicken and seafoods.

On the basis of ratings by this experienced taste panel, freeze-dried foods appear to have some prospects for volume production. Their chief market, however, may be in competition with conventionally dried foods. Similar to these, freeze-dried products are lightweight, have long shelf life, and can be stored without refrigeration. In addition, they are said to retain more of their original physical structure, flavor, and nutritive value than air or heat-dried products.

On the other hand, even though freeze-dried foods have the foregoing advantages, the fact that they rate lower in palatability than frozen and canned foods will limit the competition they can give these long established products.

FREEZE-DRIED FOODS: PALATABILITY TESTS

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INTRODUCTION

The history of food processing is a record of man attempting to reduce the effect of seasonal and geographical differences in production and use of food. Until fairly recent times, man has been faced with the problem of feast and famine; the problem of an overabundance of food at harvest time, and not enough at some periods of the year to satisfy basic nutritional needs. Also, due to specialization of present-day production, much of our food is not consumed where produced.

Down through time attempts have been made to conserve food for future use. Napoleon even offered a reward to any person who could suggest a new method for keeping food so his armies could be better fed. As a result, canning was developed and this revolutionized preservation methods of the century. Quick-freezing became important during the last quarter century and its effect on food preservation has been equally striking.

War was a stimulus to the development of the most recent method of food processing -- freeze-drying. Dried foods were important during World War II and many were used, especially where perishability and weight limitations were of consequence. However, methods then in use for drying produced foods with off-flavor. Since many of these "off-flavors" were due to the heat-drying process, considerable research was directed toward developing non-heat drying techniques. During and after World War II, the Danish Government did some exploratory work in freeze-dehydration of food. In 1951, the British Government opened the Research Establishment and Experimental Factory at Aberdeen, Scotland, and much of the freeze-drying research work now available was done at this station during the 10 years it was in existence. Today, in several countries in Western Europe as well as in the United States, food processors are promoting extensive research directed toward perfecting freeze-drying techniques and reducing production costs.

Because of the current interest in this new method of preserving food, the U. S. Department of Agriculture conducted a survey to obtain data that could be used to appraise the possible impact of freeze-dried foods on the market. Plans are to report results of this study in a later publication.

Because palatability of a product is a critical factor affecting its acceptance, as part of this study taste tests were conducted on the freeze-dried foods now on the commercial market. These foods were rated for general acceptability and for appearance, flavor, texture, juiciness, and tenderness as compared to the same food processed by canning or freezing. Results of these taste tests are presented in this report.

Though a good tasting product is important, other factors also enter into market acceptability. Of these, production costs are one of the more important. Information concerning costs of freeze-drying in plants of different capacities will be the subject of a future report.

Definition of Freeze-Drying

Freeze-drying is a drying process known as sublimation. It is the removal of moisture from a product while that moisture is frozen. Foods to be sublimated are first frozen, then placed in a drying chamber, heat is applied, and low vapor pressures removed the moisture from the product. Because the moisture never goes through the liquid stage while being removed from the food, the food does not shrink or lose shape. The final product is dried to a moisture level of 2 percent or less.

Background

This palatability study of freeze-dried foods is a phase of a larger program of research concerning the freeze-drying industry. The overall goal is to forecast, as reliably as possible, the future of the industry, and to show the effects of freeze-drying on allied or competitive industries. These include packaging, transportation, storage, merchandising, and promotion as well as canning, drying, and freezing. The complete program of research includes a study of freeze-drying processing costs, a comparison of freeze-drying costs with costs of other food processing methods, and a bibliography of freeze-dried foods.

So far as is known, this is the first publicly available information concerning taste evaluations of commercial freeze-dried foods. Some palatability work of this nature has been done by researchers in the Food and Container Institute of the Quartermaster Corps. Their studies, however, are designed mainly for armed services use. The Hedonic Scale Test, commonly used by them, measures "likes and dislikes." Other studies give results of taste tests for specific products (12). 1/ Still other studies analyze particular laboratory techniques (5, 16).

Objectives

The present study, dealing with eating quality, was designed to provide data from which estimates may be made to answer the questions:

(1) Are individual freeze-dried foods of sufficient palatability to make them acceptable?

(2) If undesirable palatability characteristics are present, what are they, and in what foods are they important?

Answers to these questions, along with consideration of other factors, would provide information on which to base estimates of consumer acceptability of freeze-dry products in retail, institutional, and manufacturing markets. These answers would also provide data helpful in making estimates for specialized uses such as for camping, emergency rations, catering, and armed services.

To answer these questions, it was necessary to obtain specific data about general palatability levels of freeze-dried items, using as criteria comparisons with products processed by the more usual methods such as canning or freezing. The specific objectives were: (1) To examine palatability aspects of freeze-dry products and similar foods processed by other methods, (2) to determine the palatability level of

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1/ Figures underlined in parentheses refer to items in Literature Cited at the end of the text.

freeze-dried foods, and to compare these levels with the comparison products, and (3) to assess the results of these tests with the aim of estimating the future of the industry.

Procedure

Food evaluating was done by U. S. Department of Agriculture (USDA) personnel in the food quality laboratory of the Human Nutrition Research Division at Beltsville, Maryland. Five experienced panel members sampled each food. During a preliminary training period panelists tasted and became familiar with a variety of freeze-dried products. Laboratory workers rehydrated and cooked several of these freeze-dried foods at that time.

It is presumed that products tested had been dried to a level of 2 percent or less of moisture. However, no moisture tests were made, so the exact moisture content of individual test products is unknown.

Distilled water was used in rehydrating and cooking all foods. It was also used in rinsing the mouth. Manufacturers' directions were followed regarding rehydration, temperatures, cooking times, and quantities of water. An exception was shrimp where the processor specified lemon juice be added to the rehydration water. This was not done since lemon juice masks the true flavor of shrimp. If rehydration instructions were not available, procedures were developed in the laboratory, using as guides instructions for similar freeze-dried products. Some freeze-dried products were packaged as complete meals and contained foods dehydrated but not freeze-dried. In several cases such as these only the freeze-dried foods were evaluated. In other instances, as for example the stews and soups, the whole item was evaluated.

The study was not designed, it should be emphasized, to answer the question as to whether the foods under consideration were as palatable as fresh products. Rather, it was designed to determine the level of palatability of freeze-dried foods when compared with other processed products. Processed foods purchased for purposes of comparison were similarly prepared products. Most of these comparison products were either frozen or canned. Canned products were heated thoroughly before serving and frozen foods were prepared in accordance with processors' instructions.

Source of Products

Products evaluated were 28 of the 33 freeze-dried foods on the market as of May 1962. Both the freeze-dry items and the comparison foods were obtained from retail stores or directly from wholesale warehouses. All were purchased at prevailing prices and no gifts of products were accepted for testing purposes. Since most products were purchased through regular trade channels, it is assumed storage and transportation conditions were normal.

The comparison food for each test was carefully chosen to meet these requirements: (1) It had been prepared by the processor in the same manner as the freeze-dried product; that is, if the freeze-dried food was cooked and diced, the comparison food was also cooked and diced; (2) it was used as foods acceptable to a large number of people. Whenever a range of food products was available permitting a selection, the product was chosen on the basis of being a large volume seller, a medium priced item, and a popular brand; (3) it was purchased at retail and it was assumed normal transportation and storage conditions prevailed.

The counterpart foods establish a point of reference and are not intended to represent ultimate palatability or highest quality possible for a particular food.

The Testing

Three replications of each food were served to panelists with an arrangement that a freeze-dried and appropriate counterpart food were not rated at the same session. Some freeze-dried products were served in a variety of ways, and each was considered separate. For example, freeze-dried shrimp was served plain. In other evaluations shrimp was prepared as a creamed dish and as a salad. Crab and chicken dishes were likewise prepared in the laboratory kitchen from the original plain products.

In the taste-panel room, free of surrounding influences, panelists were given scoring sheets and first registered their own prejudices, if any, concerning each food to be tasted. This procedure was followed so that if scores from any individual differed markedly from those of other panel members, this particular panel member's score could be disqualified provided it was clear he had a food prejudice that prevented him from being objective.

The Ratings

At each evaluation session panel members scored general acceptability and the five quality characteristics: Appearance, flavor, juiciness, texture, and tenderness. Scoring was on a 5-point scale, with half points permissible. For general acceptability, (5) represented very good, enjoyed it very much; (4) good, enjoyed it; (3) fair, acceptable; (2) poor, barely acceptable; and (1) very poor, not acceptable. Each of the quality characteristics had a similar numerical rating scale and adjective description. Thus, general acceptability, appearance, flavor, juiciness, texture, and tenderness were all evaluated at the same time on the same scoring sheet. The appendix includes a scoring sheet of the type used in the test.

Comments of panelists are selected to illustrate or point up typical reactions. They are neither edited nor analyzed, and are presented to provide subjective evaluations that may aid in interpreting scores. Since there were 5 panelists and 3 replications, there was an opportunity for 15 comments to be made concerning each product, for each palatability characteristic. Only comments mentioned as many as five times are included.

Statistical Treatment and Meaning

The appendix gives details concerning statistical methodology, although a little background may be of value here in interpreting the charts.

In evaluating the results of the ratings, one problem was to determine whether a difference between two mean scores of the processing methods was great enough to be due to the processing method, or was due to chance variation. F tests were applied to the scores and are used as guides throughout the analysis. For flavor .9 points difference between scores is needed for significance. In all other palatability characteristics, including general acceptability, appearance, juiciness, texture, and tenderness, .7 points of difference are needed to denote statistical significance. These two figures, .9 for flavor and .7 for all the other palatability traits, may be used as guides in observing the charts through the text and the appendix tables. These two figures were derived at the 1-percent level.

PALATABILITY COMPARISONS

Figures 1 through 28 show palatability comparisons for the foods evaluated by the panel. In each chart a freeze-dry food is compared directly with its standard. This is done for each of the six categories: General acceptability, appearance, flavor, juiciness, texture, and tenderness. More precise information concerning each food evaluated is given in the appendix tables. Foods are grouped in the presentation so most beef items are discussed together. Poultry, seafoods, soups, and miscellaneous foods are other groups.

Beef

The five beef products evaluated include diced beef, steaks, sliced beef and gravy, swiss steak, and beef stew. All were cooked before being frozen and dried. The comparison product for diced beef was canned beef. All other products for comparisons were frozen. No tests were made to determine the percentage moisture of these beef products, nor was the length of storage ascertained or controlled. Research results by Thomson and others (14) show freeze-dried beef with low moisture (1.7 percent) stored much longer and better and rehydrated more completely than meat dried to 3.9 percent and 5.1 percent moisture. Thomson's study confirmed results obtained earlier by Furgol (6) that freeze-dried meat should contain 2 percent or less of moisture.

Diced Beef

Freeze-dried beef dices tested inferior to the canned dices used for comparison (fig. 1). This statement was true for general acceptability and also applied to juiciness, texture, and tenderness. Appearance and flavor scores for the two products were statistically similar.

Comments concerning freeze-dried diced beef were that the meat was "dry" and "lacking in flavor." Other comments noted it as "tough," "fibrous," "stringy," and "poor in color." Canned beef dices were criticized as "salty."

Diced beef was not prepared as a mixed dish (as were chicken, shrimp, and crab) so it is not known whether beef would have improved in a mixture as the others did.

Beef Steaks

Freeze-dried beef steaks received lower scores for tenderness and juiciness (fig. 2). In all other characteristics they were similar to the frozen steaks. These steaks were described by panelists as "watery or mushy" or "dry, yet oozing juice." Other studies show rehydration to be a major factor determining toughness of freeze-dried beef (2, 15).

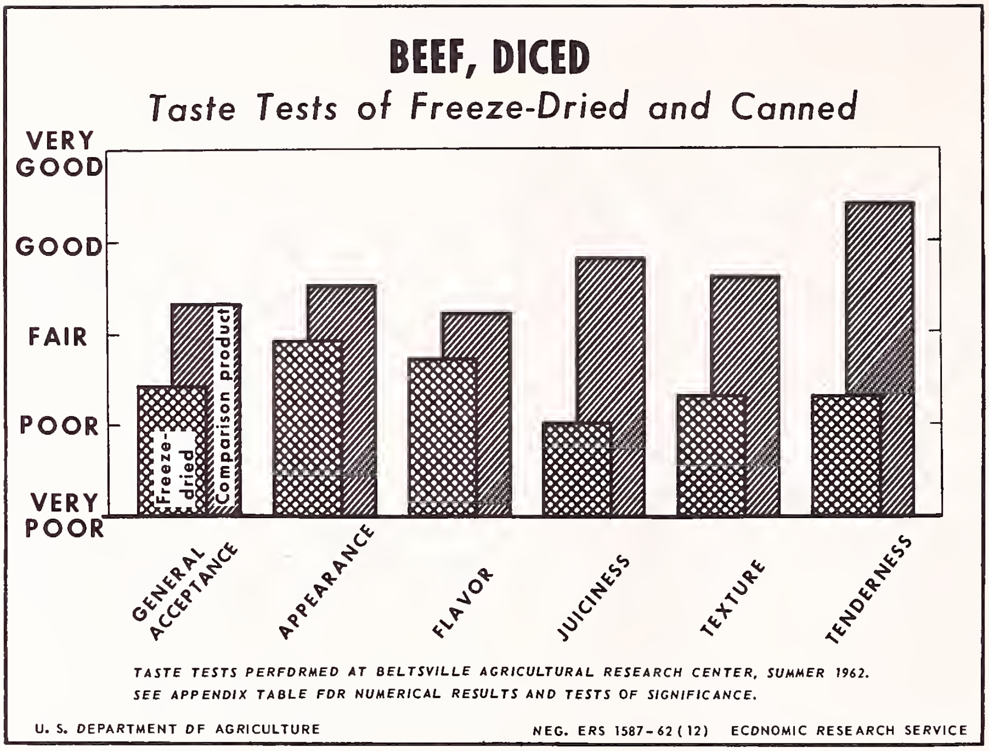


Figure 1

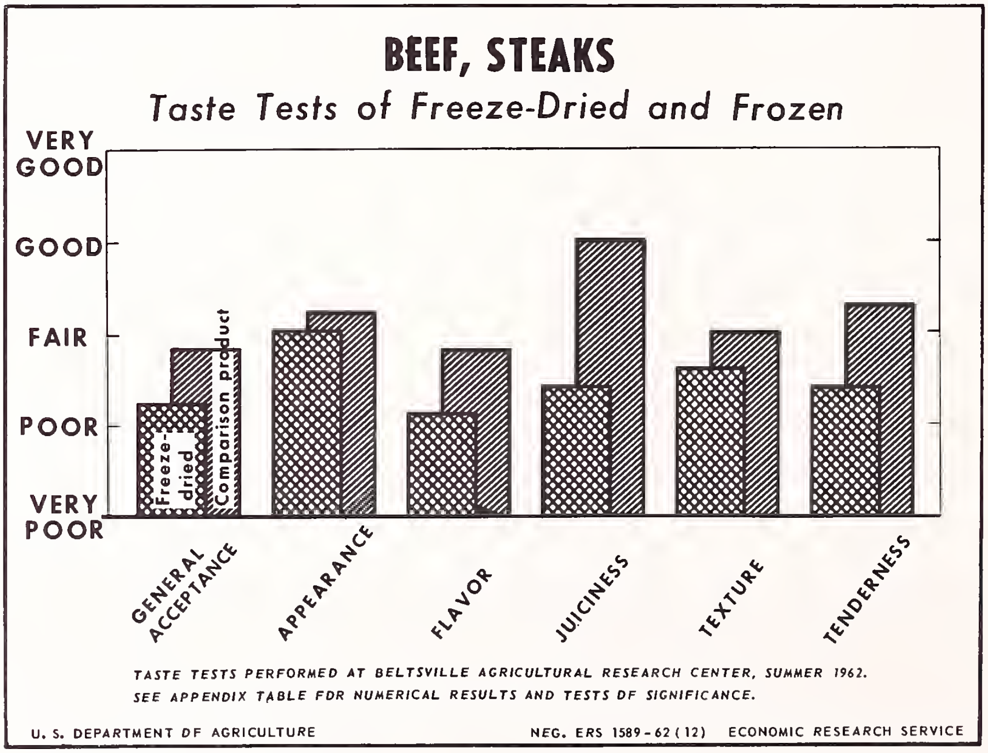


Figure 2

Sliced Beef and Gravy

Mean scores for freeze-dried sliced beef were low when compared with frozen sliced beef scores (fig. 3). This was true in all taste characteristics. Comments of panelists included "dry," "stringy," "fibrous," "gravy, watery and separated," and "beef looks like leather." Although the frozen product was also criticized as being "dry," "flavorless," and "tough," the panelists nevertheless considered the frozen comparison product superior to the dried food.

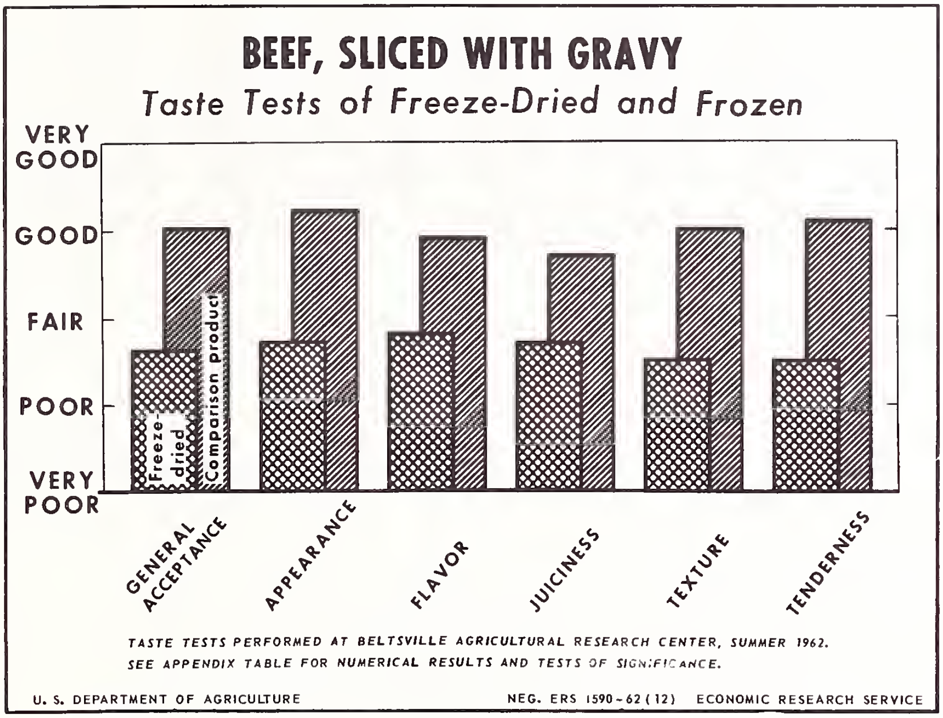


Figure 3

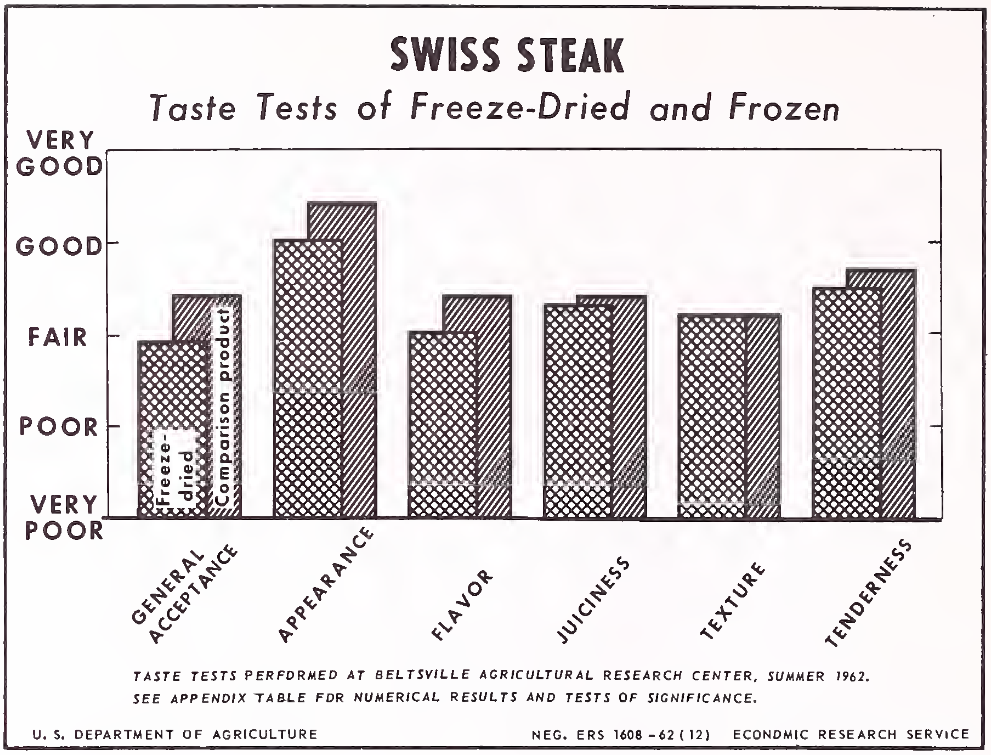
Swiss Steak

Steak (from the swiss steak dinner) received palatability scores almost identical to frozen swiss steak (fig. 4), and is estimated to have the same palatability. Adverse comments were "fibrous and stringy," "dry," and "off-flavor." Other ingredients of this swiss steak dinner tested included freeze-dried peas (tested separately) and air-dried potatoes (not tested).

Beef Stew

The beef stew evaluated was packaged in two laminated foil containers. In the one pouch the freeze-dried ingredients, beef and snap beans, were packaged. In the other there were potatoes, onions, and carrots -- air-dried products. The complete stew was prepared and compared with a complete canned beef stew.

Little difference was noted between scores of freeze-dried vegetable beef stew and the canned vegetable beef stew (fig. 5). Comments indicated that the freeze-dried meat was "tough," the stew "off-flavored," and the green beans "underdone." The canned stew was also criticized for its "tough" meat.



SWISS STEAK

Taste Tests of Freeze-Dried and Frozen

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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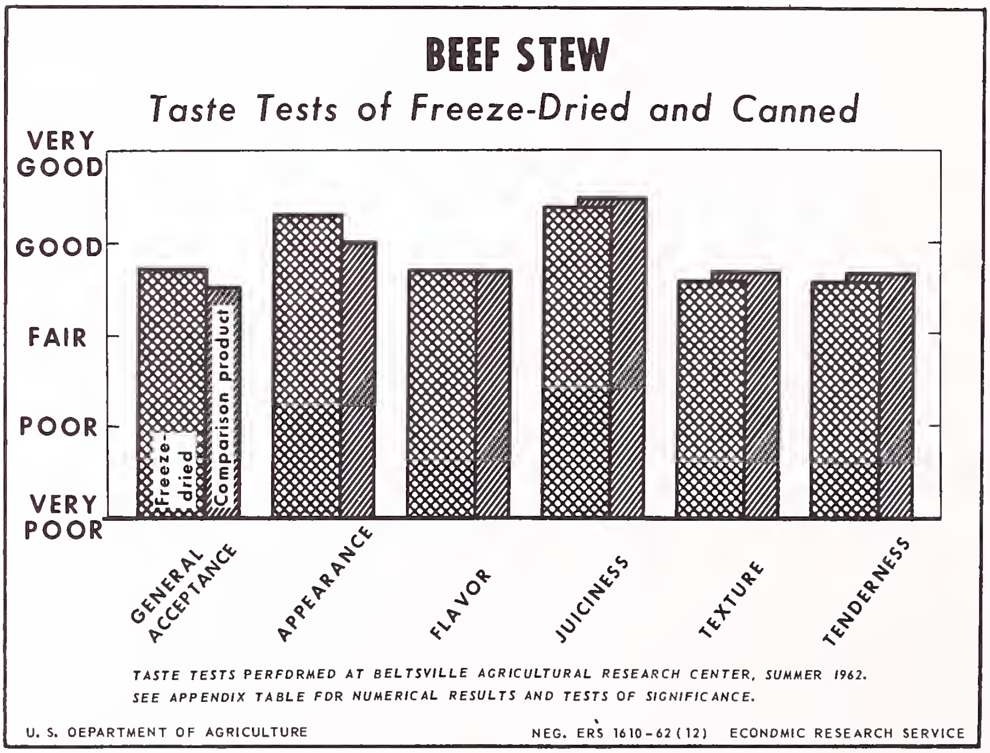
Figure 4



BEEF STEW

Taste Tests of Freeze-Dried and Canned

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Figure 5

Summary of Beef Products

Freeze-dried beef was judged somewhat inferior to the products with which it was compared. This was true for all beef items except swiss steak and beef stew, which were rated even with the comparison products. The limiting factor in the other beef products appeared to be dryness (9). Since juiciness is related to flavor, texture, tenderness, and general acceptability, juiciness may also account for low scores evidenced in cases where these were scored low.

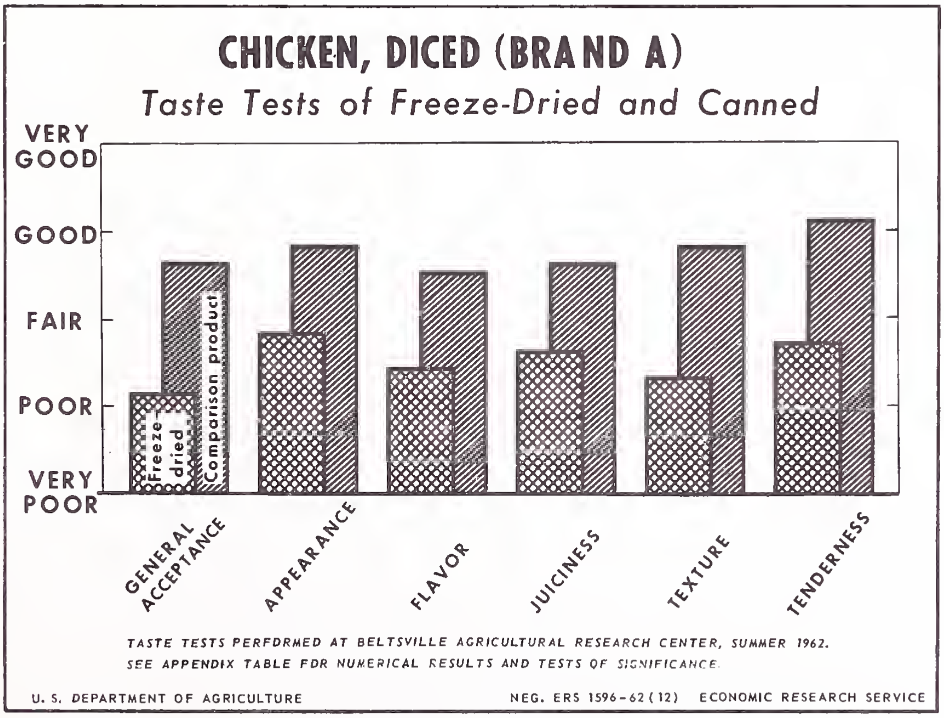
Chicken

Six taste tests were made of freeze-dried chicken products. Two of these, brand A and brand B (both diced) were served plain. Two other dishes, a chicken salad and creamed chicken, were laboratory prepared from freeze-dried chicken and compared with dishes prepared from canned diced chicken. The remaining two were manufactured mixes, chicken stew and chicken and rice dinner.

Diced Chicken - Plain

Two brands of chicken dices were compared with canned chicken. In each evaluation canned chicken was judged superior to the freeze-dried product. This applied to all the palatability aspects under consideration. Little difference was noted between brands of freeze-dried chicken, although this difference was not statistically analyzed (figs. 6 and 7). In each palatability aspect for both freeze-dried brands, the ratings ranged from "poor" to "fair."

The main adverse comments by panelists concerned "toughness" and "off-flavor" of the freeze-dried diced chicken meat.



CHICKEN, DICED (BRAND A)
Taste Tests of Freeze-Dried and Canned

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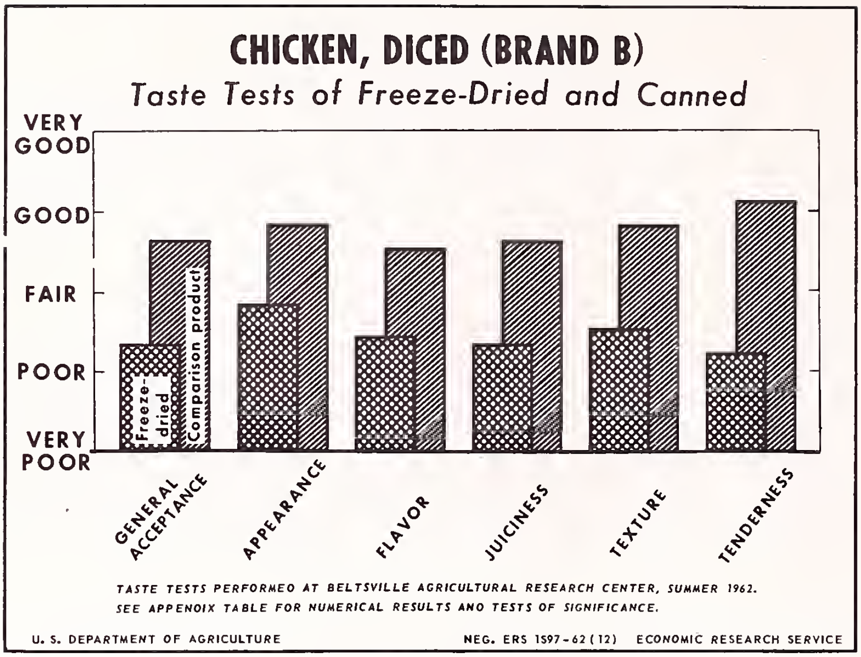
Figure 6


CHICKEN, DICED (BRAND B)
Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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Figure 7

Chicken Salad

Salad prepared from brand A freeze-dried chicken dices had mean scores lower than scores of canned chicken salad (fig. 8). This pertained to all palatability characteristics. There are some indications that the chicken salad thus prepared was judged better from a palatability viewpoint than plain chicken dices. Such differences though were not great enough to be judged statistically reliable.

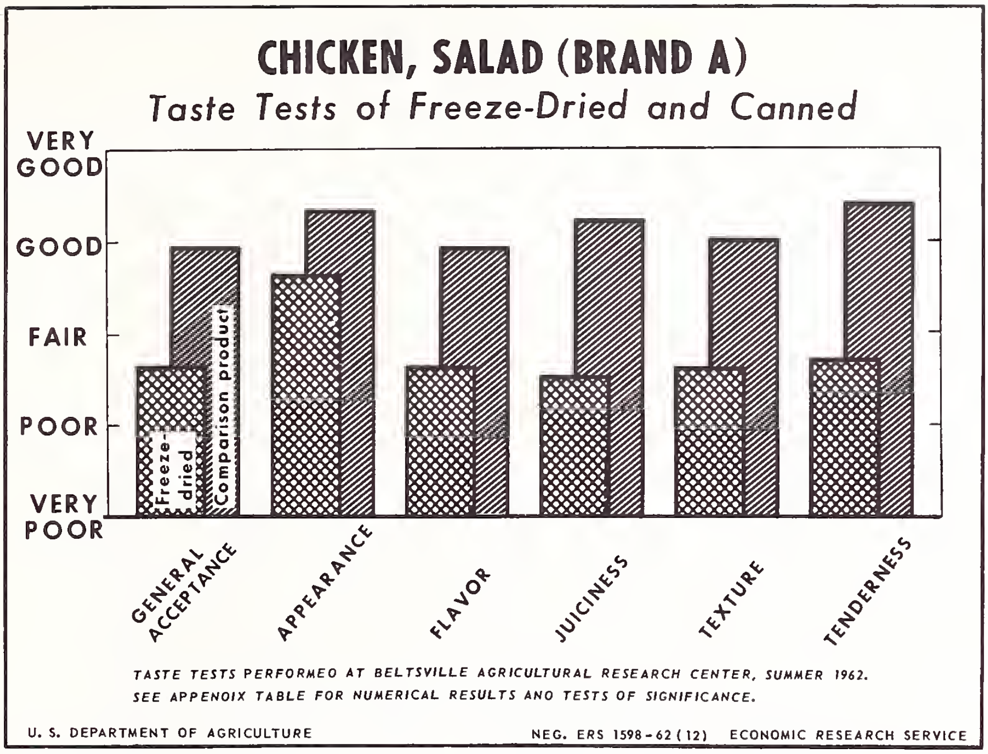
Adverse comments about the salad prepared from freeze-dried chicken dices centered about its "toughness" and "woodiness."

Cream Chicken

Freeze-dried chicken, creamed in the laboratory, was prepared using brand A chicken dices (fig. 9). Here, freeze-dried creamed chicken was rated higher than when the same product was served plain. In this case, the freeze-dried product compared favorably in all palatability aspects to creamed chicken made from canned dices.

The main adverse comments concerning freeze-dried creamed chicken were that it was "dry" and "tough." These "tough" comments indicate dryness resulting from lack of complete rehydration. Since manufacturers' instructions were followed in the laboratory, poor rehydration is attributed to poor processing techniques or inadequate instructions. The "off-flavor" comment mentioned for the plain dices was not mentioned for the chicken salad nor the creamed dish. This indicates the other ingredients or spices covered up the off-flavors discernible in the plain products.

These findings are verified by unpublished results of taste panel work done at the School of Hotel, Restaurant, and Institutional Management -- Kellogg Center, Michigan State University. There chicken, crab, and shrimp received higher scores when served in such mixtures as chow mein and tetrazzini than when served alone.



CHICKEN, SALAD (BRAND A)

Taste Tests of Freeze-Dried and Canned

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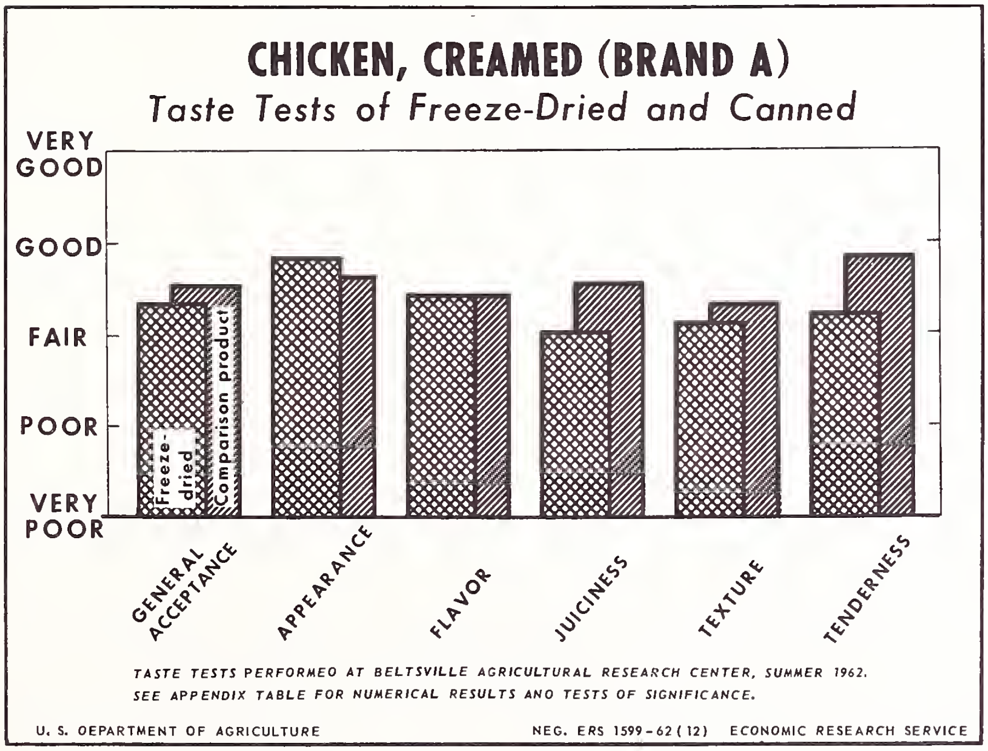
Figure 8



CHICKEN, CREAMED (BRAND A)

Taste Tests of Freeze-Dried and Canned

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Figure 9

Chicken Stew

Freeze-dried chicken stew had scores inferior to scores of canned chicken stew. This applied to general acceptability, flavor, texture, and tenderness (fig. 10). Mean scores of the two foods being compared were about the same in appearance and juiciness evaluations. Freeze-dried chicken stew had scores slightly above "poor" for flavor, texture and general acceptability. In the other palatability aspects this freeze-dried product had scores that were "fair" or "good."

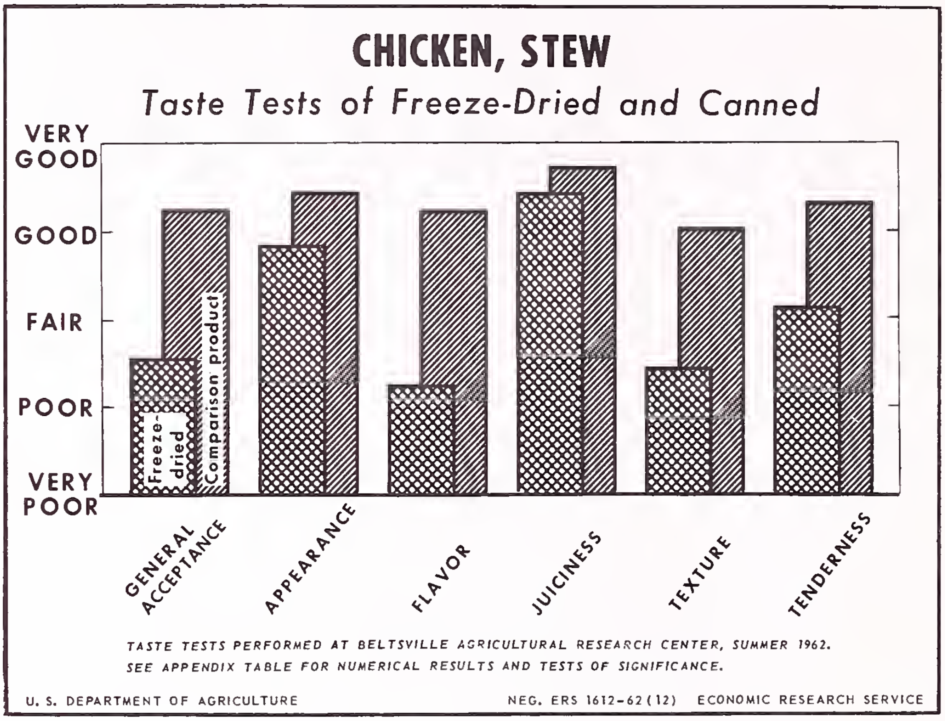

Figure 10

Freeze-dried chicken stew was said to be "off-flavored" and the vegetables "underdone." Panel members' comments indicated off-flavors were present in the air-dried products rather than in the freeze-dried ingredients of the mix. The canned product was said to contain "stringy chicken."

Chicken and Rice Dinner

For the chicken and rice dinner evaluation no comparable processed comparison product was found on the retail market. Thus, the comparison food was prepared in the laboratory kitchen. The prepared chicken and rice dinner scores were higher than the freeze-dried chicken and rice dinner scores in all aspects except appearance (fig. 11). The general level of scores for this freeze-dried product ranged from "poor" to "fair." The prepared comparison product scores ranged from "good" to "very good."

The freeze-dried chicken and rice dinner was said to have a "cardboardy, chalky, and powdery" taste. The rice was judged "gummy and pasty," and the chicken "fibrous and tough." A definite aroma described as "wet cardboard" was noted while the dinner was being prepared in the laboratory. The laboratory prepared chicken and rice dinner had few adverse comments.

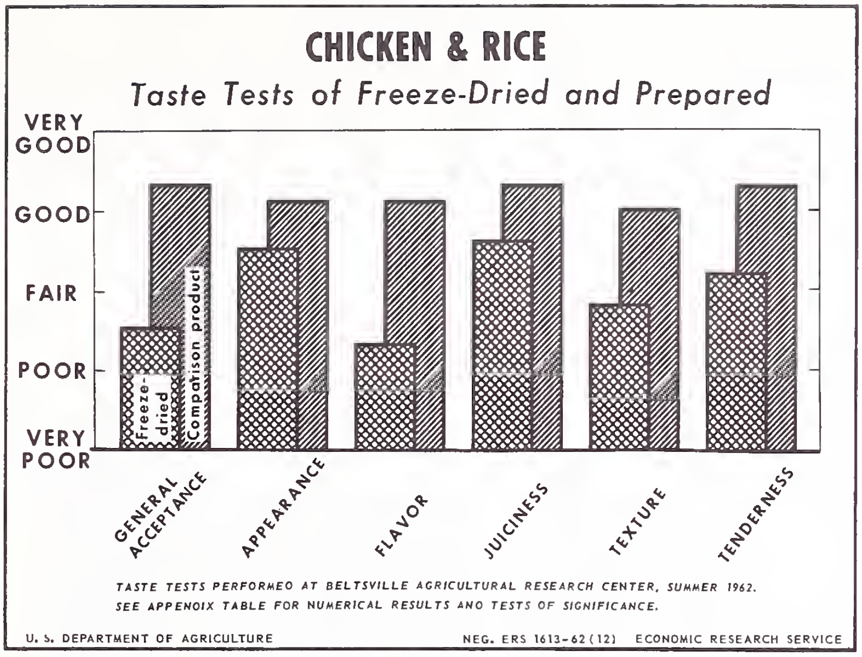

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Figure 11

Summary of Chicken

In considering the group of chicken products, we find that in most palatability characteristics the freeze-dried items had lower scores than those of the control group. Greatest differences were noted in flavor, texture, and general acceptance. In appearance, freeze-dried chicken showed the highest relative scores. It may again be pointed out that freeze-dried chicken improved as other ingredients were added to the prepared dishes, and this improvement may have been the result of more complete rehydration as well as covering up some lack of flavor. As with seafoods, flavor seems the key palatability characteristic lowering the general acceptance scores.

Seafoods

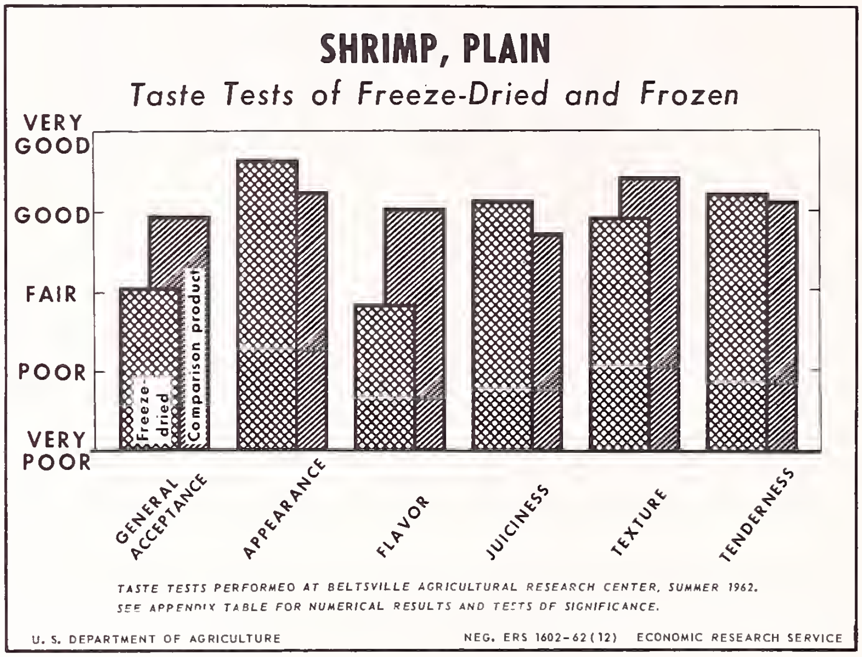
Six seafood evaluations were conducted. These were of plain shrimp, shrimp prepared into a salad in the laboratory, shrimp made into a creamed dish in the laboratory kitchen, and shrimp creole prepared as a mix in the processing plant. Also there were plain crab meat and crab meat made into a salad in the laboratory.

Shrimp was one of the first freeze-dried food products entered on the market, although at present it is available only to institutional buyers. The shrimp creole, however, is available in a camp pack.

Much research work has been done with various freeze-dried fish products at Aberdeen (7) and elsewhere. However a basic problem still existing is the one of complete rehydration which is investigated by Connell (3).

Shrimp - Plain

Freeze-dried shrimp was about the same palatability level as frozen shrimp (fig. 12). They were both between "fair" and "good" on the scale. The only marked differences between the two products were in flavor and general acceptability, and in both aspects the freeze-dried shrimp was inferior. Probably general acceptability was low as a direct result of the low flavor rating.



SHRIMP, PLAIN

Taste Tests of Freeze-Dried and Frozen

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Figure 12

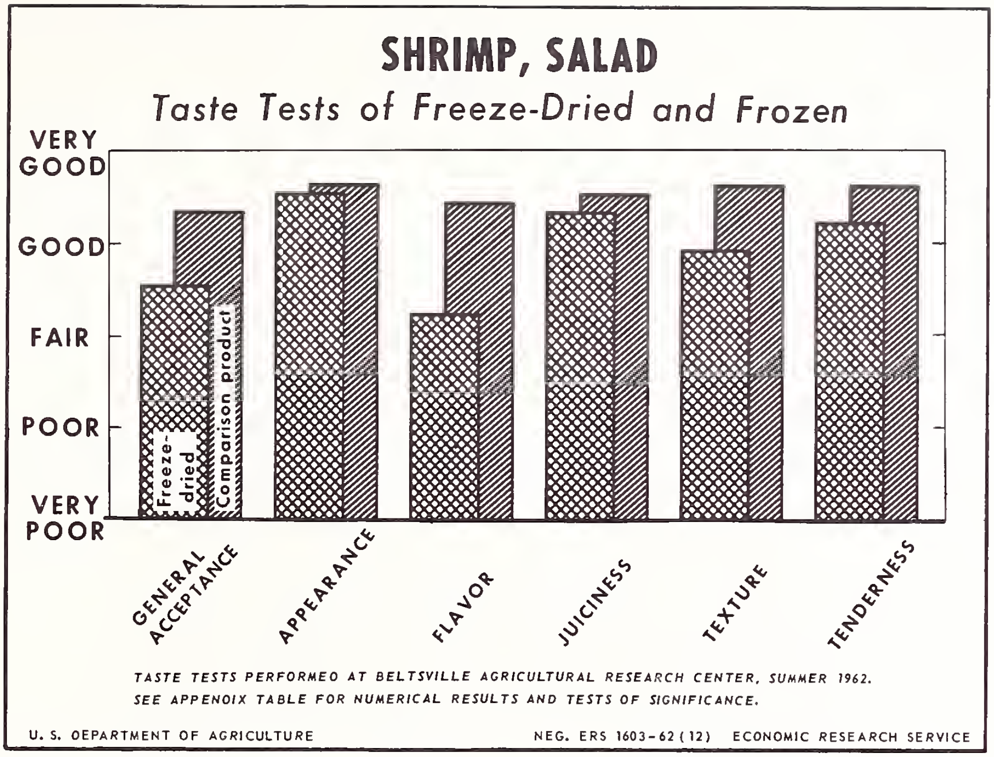
In spite of the low scores for freeze-dried shrimp, the panelists made no adverse comments regarding it. Frozen shrimp, though, was criticized as "tough" and "flat in flavor."

Shrimp Salad

Preparing plain freeze-dried shrimp into a shrimp salad had the effect of raising general acceptability and flavor scores, figure 13, so that freeze-dried shrimp salad had scores higher than plain freeze-dried shrimp. This also occurred with frozen shrimp, but to a smaller degree. As with plain shrimp, described above, freeze-dried shrimp salad was of the same statistical population as frozen shrimp salad in appearance, juiciness, and tenderness. In general acceptability, flavor, and texture, freeze-dried shrimp salad was judged inferior. Few adverse comments were listed.

Creamed Shrimp

Creamed freeze-dried shrimp was approximately of the same palatability quality as creamed frozen shrimp (fig. 14). The only exception noted was in juiciness. Here, freeze-dried shrimp attained a significantly lower score than frozen shrimp.



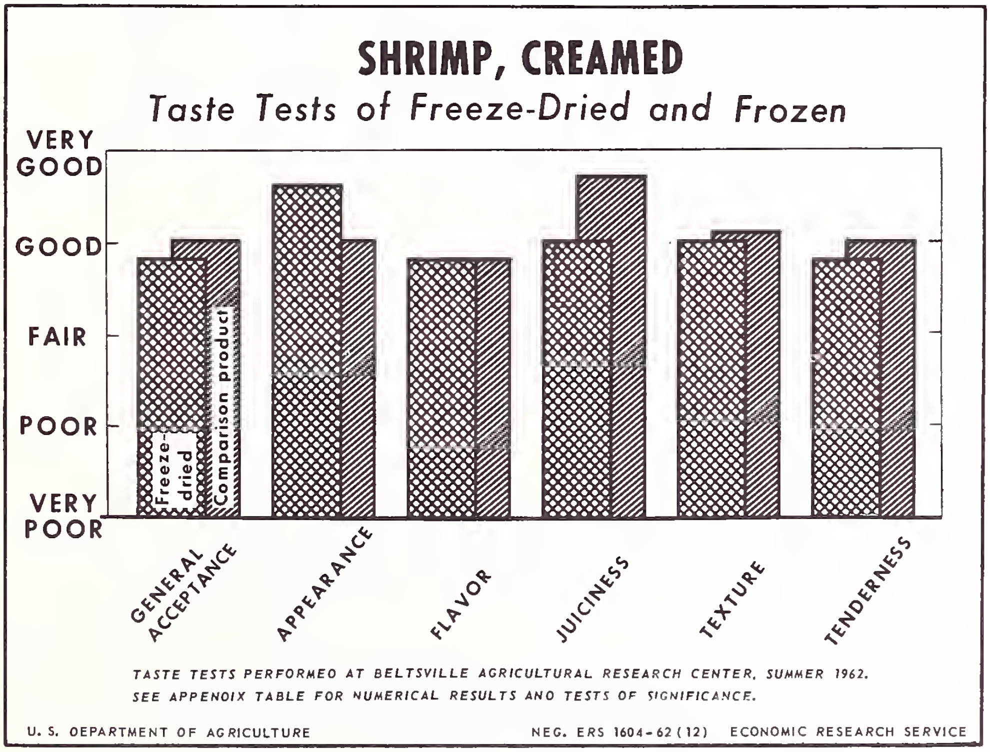
SHRIMP, SALAD

Taste Tests of Freeze-Dried and Frozen

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 1603-62 (12) ECONOMIC RESEARCH SERVICE

Figure 13



SHRIMP, CREAMED

Taste Tests of Freeze-Dried and Frozen

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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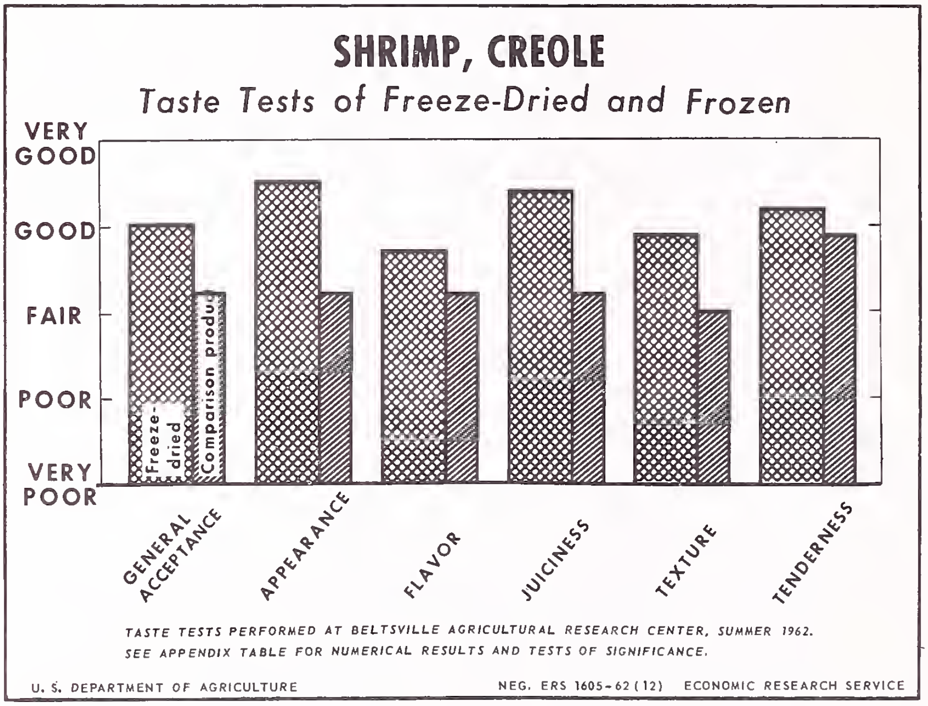
Figure 14

"Toughness" was the only adverse comment of note and applied to both freeze-dried and frozen creamed shrimp.

Shrimp Creole

Freeze-dried shrimp creole taste scores were equal to or higher than frozen shrimp creole scores (fig. 15). From the data available, we conclude the freeze-dried creole was superior to the frozen creole in all palatability aspects except flavor and tenderness. In these two aspects the two products were equal. As to the general level of comments, the freeze-dried creole was "good" to "very good" in all aspects.

Few adverse comments of note were listed by the panel members concerning freeze-dried shrimp creole. Adverse comments noted for the comparison frozen shrimp creole were that it was too "juicy or watery."



TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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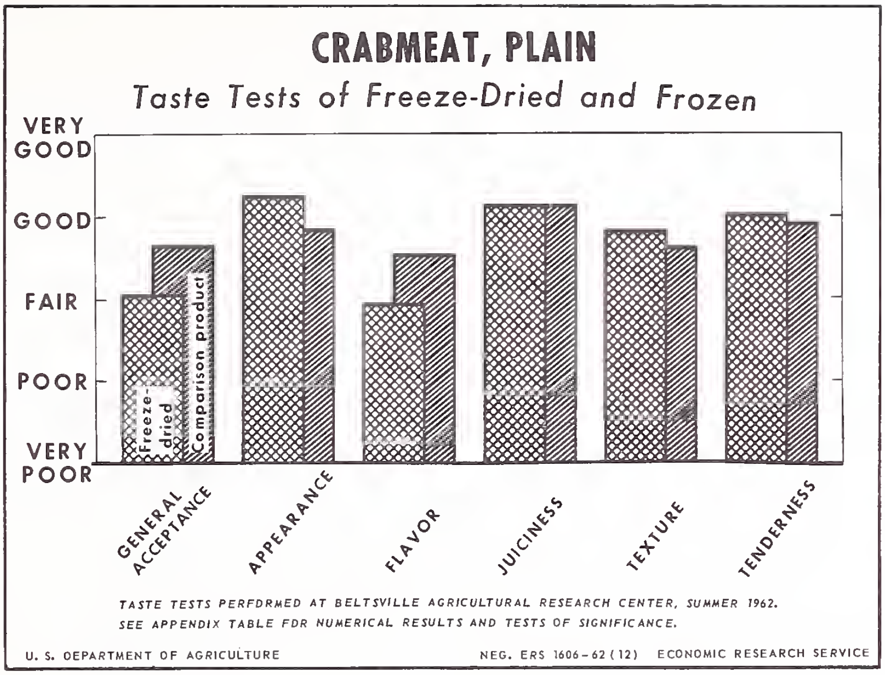
Figure 15

Crab Meat - Plain

Freeze-dried crab meat was judged by the panelists as being of equal quality with frozen crab meat (fig. 16). This was true for all palatability characteristics. Mean scores were "fair" for general acceptability and flavor, and "good" for the other palatability characteristics. As with shrimp, flavor appeared to be the factor influential in general acceptability. Adverse comments were rare for both freeze-dried and frozen crab.



CRABMEAT, PLAIN

Taste Tests of Freeze-Dried and Frozen

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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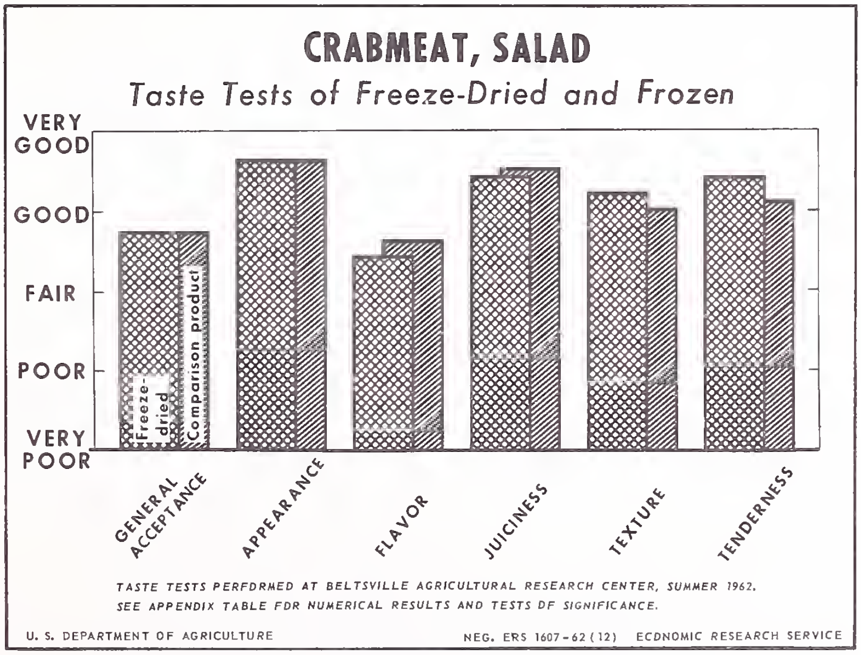
Figure 16

Crab Salad

The same crab that was served plain was also laboratory prepared as crab meat salad. As with chicken and shrimp, scores for "flavor" and "general acceptability" were higher when the product was part of a prepared dish (fig. 17). All scores were high for this freeze-dry product although about equal to frozen crab salad. No adverse comments of either freeze-dried or frozen crab meat were noted.



CRABMEAT, SALAD

Taste Tests of Freeze-Dried and Frozen

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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Figure 17

Summary of Seafoods

In juiciness, appearance, texture, and tenderness freeze-dried seafoods were little different from frozen seafoods. In general acceptability and flavor, however, mean scores of freeze-dried seafoods were lower than mean scores of frozen shell fish. It may be that flesh of shell fish is particularly suited for this preservation method.

In any event, high scores were evidenced for the plain products, and the level of the scores became higher as these products were prepared into dishes.

Within the group of seafoods "flavor" appeared as the key taste characteristic. If "flavor" is poor, then we expect "general acceptability" level to be low. If "flavor" is good, general acceptability rates high. Among these particular panelists a "fishy" taste was most often the offending flavor. It is quite possible that in other panels a "fishy" taste in seafood would be favorable. It is reported that in some areas of Europe, particularly the Scandinavian area, the general populace places a premium on a "fishy" taste in fish.

An overall appraisal of the palatability characteristics of freeze-dried seafoods is that they are of high quality. They equal frozen seafoods in all palatability aspects except flavor.

Soups

Six freeze-dried soups were tested and several brands were involved. Juiciness, texture, and tenderness tests are difficult to perform with soup products and figures 18 to 23 have "data not available" in these three characteristics. Soups used as comparison products were canned, well-known brands, and large volume sellers.

Beef Noodle Soup

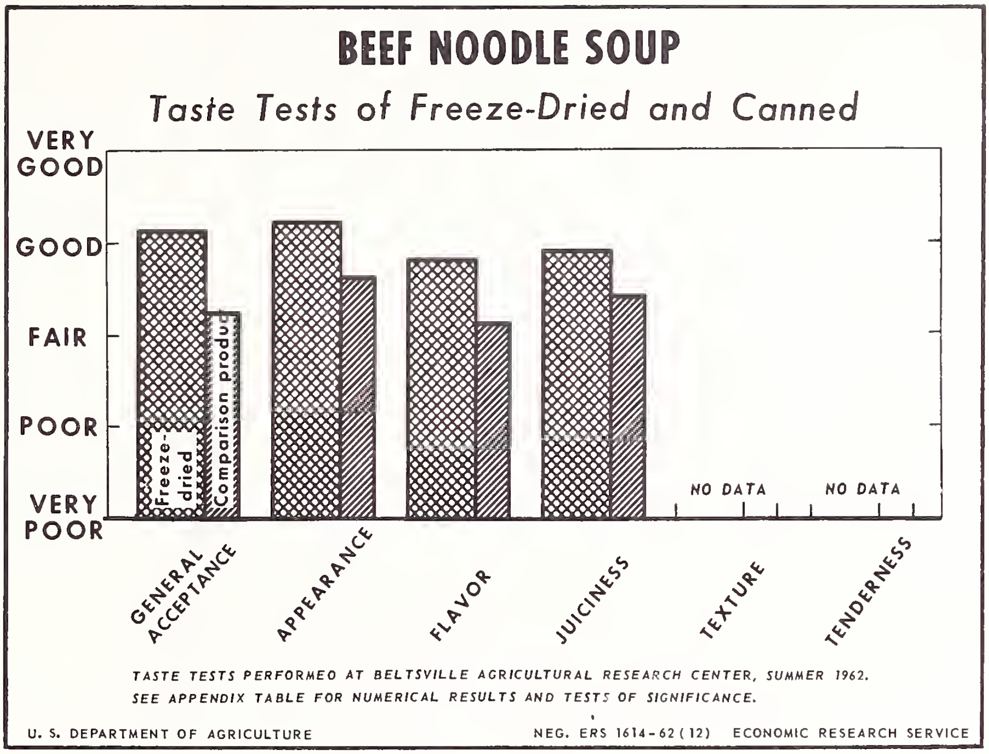
In general acceptability, freeze-dried beef noodle soup was judged superior to canned beef noodle soup (fig. 18). Freeze-dried scores were also higher for appearance, flavor, and juiciness, but these differences were minor. The only adverse comment was that the meat was "tough." In the canned product the meat was considered "tough" and the noodles "soggy" and "off-flavor."

Mushroom Soups

Two mushroom soups, brand A and brand B, were evaluated. Brand A appeared to be about the same as the canned comparison product (fig. 19). Brand B mushroom soup, shown in figure 20, had scores somewhat lower than the comparison product, but only in appearance were score differences great enough to be significant. No test was made to determine whether brand A was superior to brand B. The only adverse comment of note was that the mushrooms were "tough" in the one brand.

Chicken Noodle Soups

Two chicken and noodle soup brands were compared with the canned soup, but not with each other. Brand A soup, figure 21, was better than the comparison canned

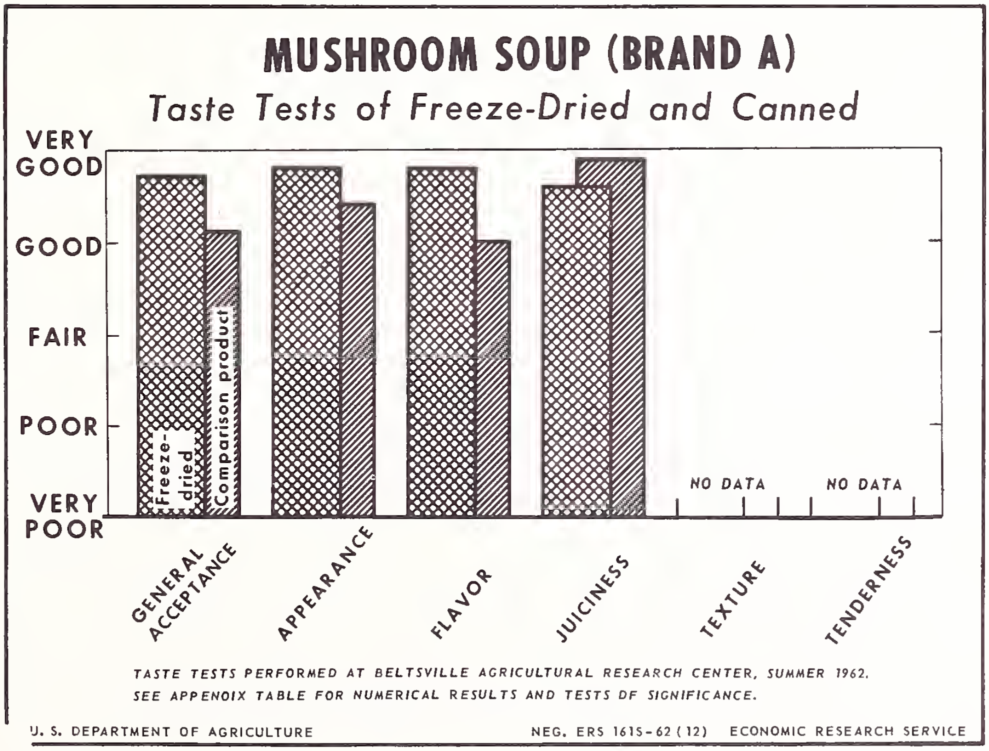

BEEF NOODLE SOUP

Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 1614-62 (12) ECONOMIC RESEARCH SERVICE

Figure 18

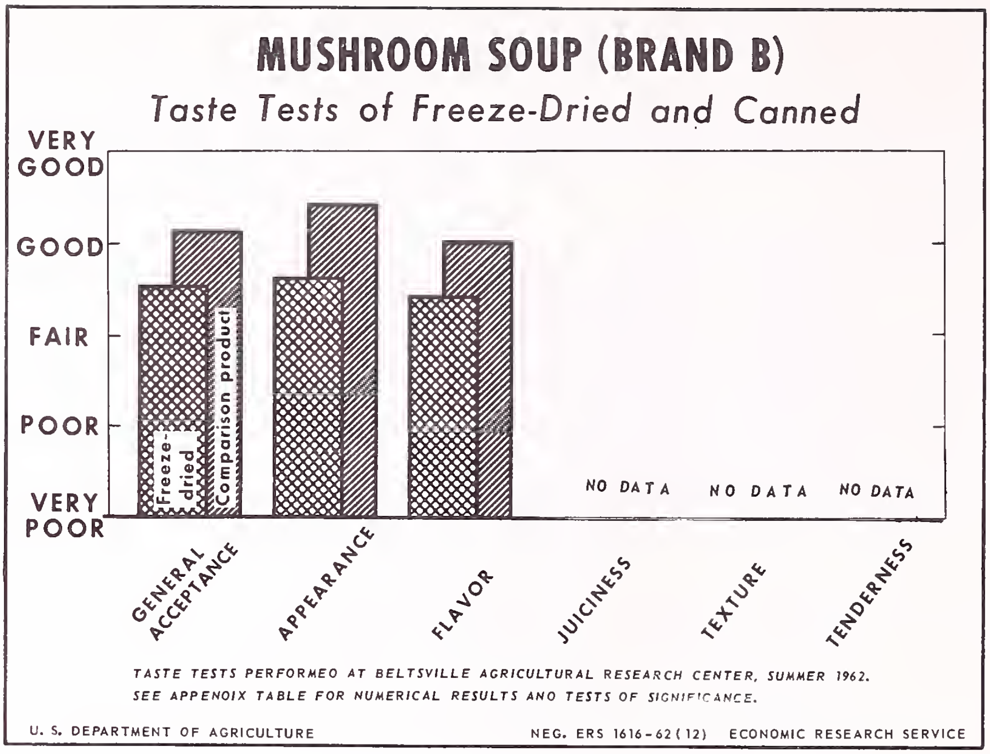

MUSHROOM SOUP (BRAND A)

Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 1615-62 (12) ECONOMIC RESEARCH SERVICE

Figure 19



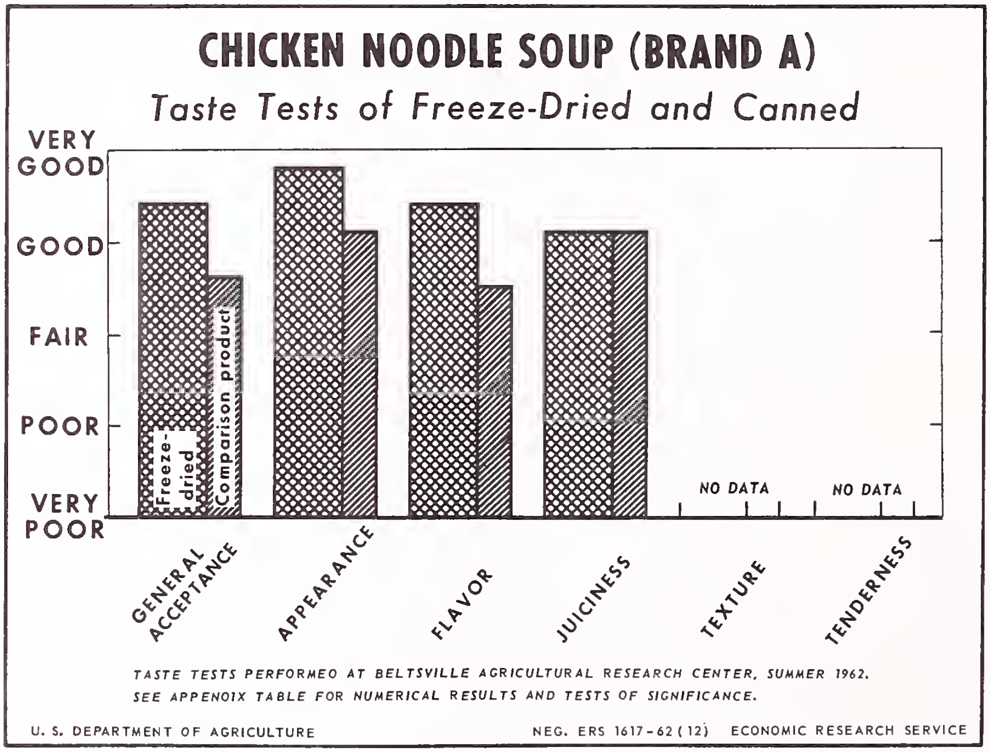
MUSHROOM SOUP (BRAND B)

Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 1616-62 (12) ECONOMIC RESEARCH SERVICE

Figure 20



CHICKEN NOODLE SOUP (BRAND A)

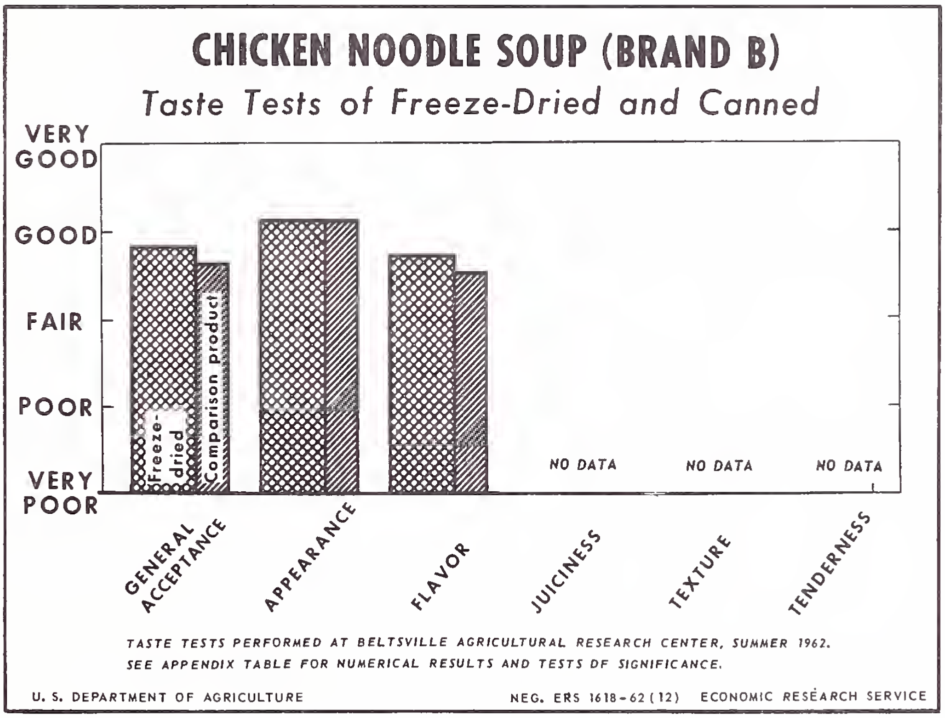
Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 1617-62 (12) ECONOMIC RESEARCH SERVICE

Figure 21

chicken noodle soup in general acceptability, appearance, and flavor and the same in juiciness. Brand B soup was about the same as the canned soup in all taste characteristics (fig. 22). The only adverse comments of panelists concerning brand A was that the chicken seemed "tough." In brand B, the most common comment was that there was "little or no chicken" in the product. Panel members noted the canned comparison soup was "fatty," the noodles "slimy," and the appearance "cloudy."


CHICKEN NOODLE SOUP (BRAND B)

Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 1618-62 (12) ECONOMIC RESEARCH SERVICE

Figure 22

Chicken Rice Soup

Freeze-dried chicken rice soup came out almost identical in palatability to canned chicken rice soup (fig. 23). This was true for general acceptability, appearance, flavor, and texture. In tenderness, the canned soup was judged superior. Panel members indicated the chicken was "tough," "woody," and "weak in flavor." This weak flavor comment was also noted with the canned chicken rice soup. In addition, canned soup had "soggy" rice and "brownish" appearance.

Summary of Soups

In appraising the group of soups, they may be described as being as good as or better than the canned soups used as comparison standards. In appearance and flavor freeze-dried soups appeared to have an advantage over their canned counterproducts. In summary, freeze-dried soups merited high scores and attained superiority among the freeze-dried foods evaluated.

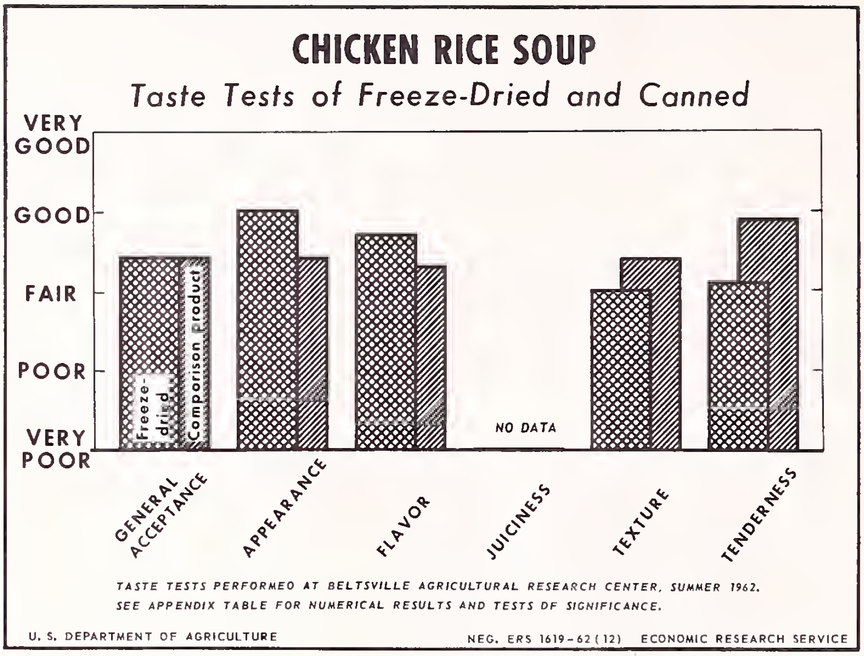


Figure 23

Miscellaneous Products

The miscellaneous products tasted included several combination dishes. There were peas from a prepared dinner and a chili and bean mixture. Also rated were both the eggs and sausage from a breakfast combination. The remaining product was diced ham. All five foods were designed for camping.

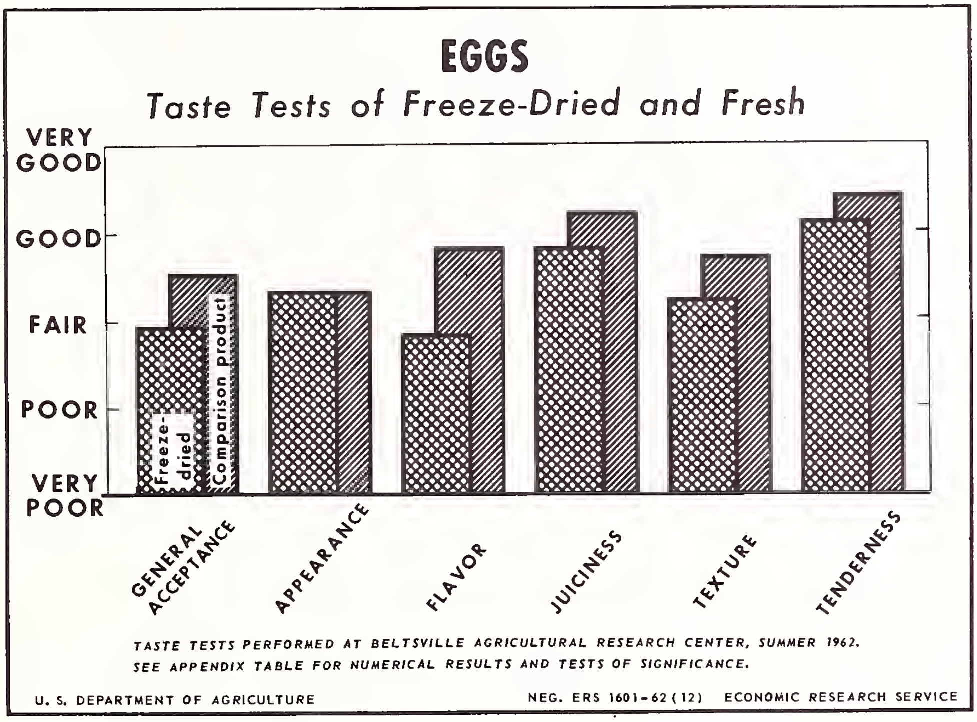
Several problems were noted during preparation of some of these foods during preliminary testing. All these combination dishes were cooked at medium to low heat on electric ranges equipped with voltage control regulators. Some of these particular foods had a tendency to stick to the pan and had to be stirred frequently to prevent scorching even though processors' directions suggested only occasional stirring.

Eggs

Samples of freeze-dried scrambled eggs were heated in sausage drippings. Addition of the fat appeared influential in the score. This scrambled egg product, patented by the Quartermaster Research and Engineering Command, was developed to be used in the Army's newly-developed Quick-Serve meals. Tests of the Research and Engineering Command show rehydration time is less than 3 minutes. These eggs are said to have storage stability of 6 months at 70° F. when packaged at oxygen levels of less than 1.5 percent. Moisture level is less than 2 percent.

The comparison products for these freeze-dried eggs were scrambled eggs prepared in the laboratory kitchen from fresh eggs. Fresh eggs were chosen because no cooked scrambled eggs were available on the retail market. In a study made at the University of Washington, freeze-dried, spray-dried, frozen, and fresh eggs were made into custards and compared in panel tests (8). Here it was reported freeze-dried eggs were equal to fresh and spray-dried eggs, and superior to the frozen eggs.

Figure 24 shows freeze-dried scrambled eggs were judged to be poorer in flavor than the fresh egg product. In other palatability characteristics the two egg products were quite similar. "Off-flavor" was the main adverse comment noted by panelists.



TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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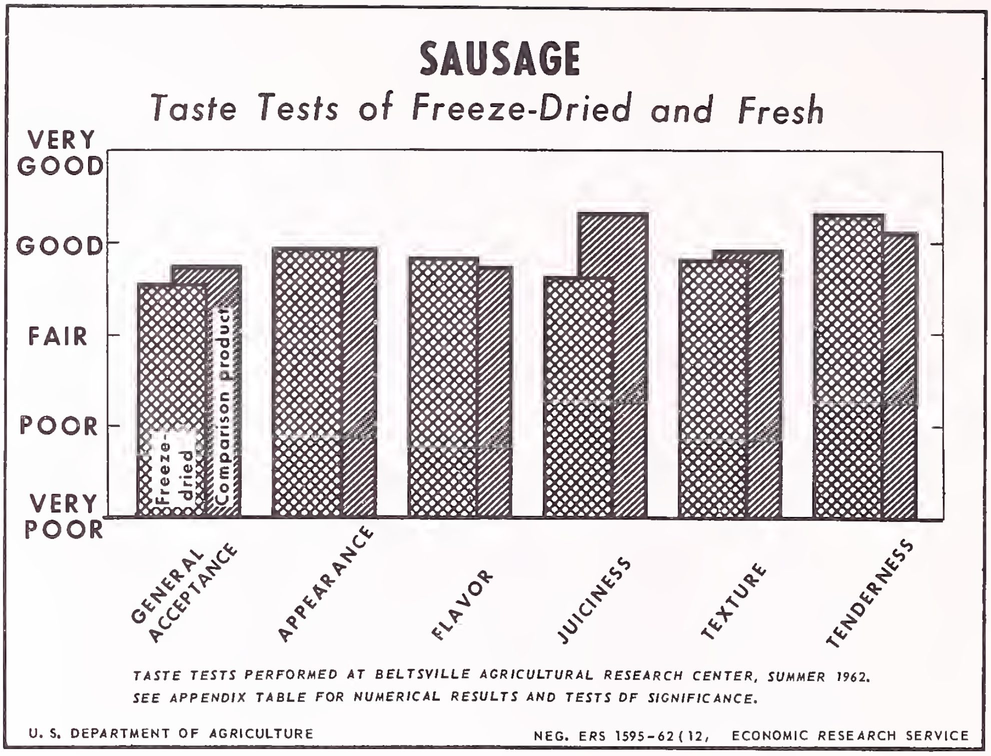
Figure 24

Sausage

Freeze-dried and fresh-frozen sausage were about equal in all palatability characteristics except juiciness (fig. 25). Here the freeze-dried product tested inferior. Comments from panelists also indicate freeze-dry sausage to be slightly dry. Other comments were concerned with sausage "mix" rather than the processing method, and no particular ones were noted for either freeze-dried or freshly-frozen sausage. Freeze-dried sausage evaluated in this experiment is sold in a combination breakfast package. The other ingredient in this package is scrambled eggs shown in figure 24.

Diced Ham

General acceptability for diced ham was "good" (fig. 26). In fact, in all taste characteristics except tenderness freeze-dried ham was comparable to the canned ham used for comparison purposes. In spite of the low score received by the freeze-dried ham in tenderness, the comments concerning freeze-dried ham referred to quality of the ham itself rather to the toughness of the product. Other studies (10) have shown meat toughness to be a complicated problem and it is possible the lack of a higher score in tenderness may be due to other factors than the processing method.



SAUSAGE

Taste Tests of Freeze-Dried and Fresh

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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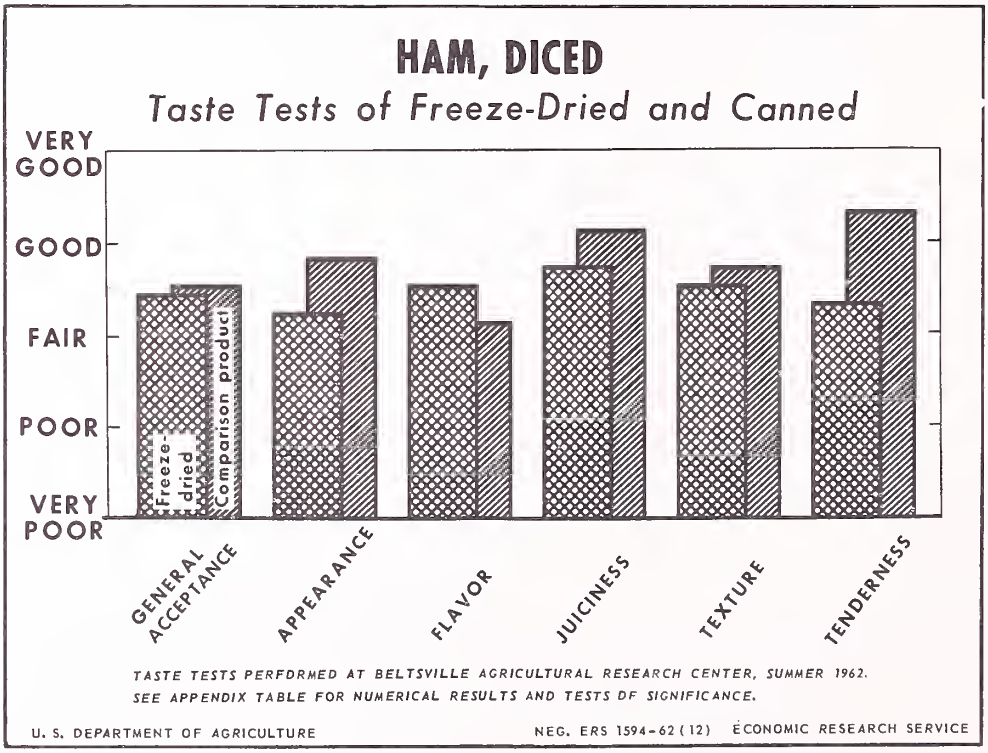
Figure 25



HAM, DICED

Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE.

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Figure 26

Peas

Peas (from the swiss steak dinner) had all palatability scores lower than frozen peas (fig. 27). In most aspects the peas were judged as being between "poor" and "fair."

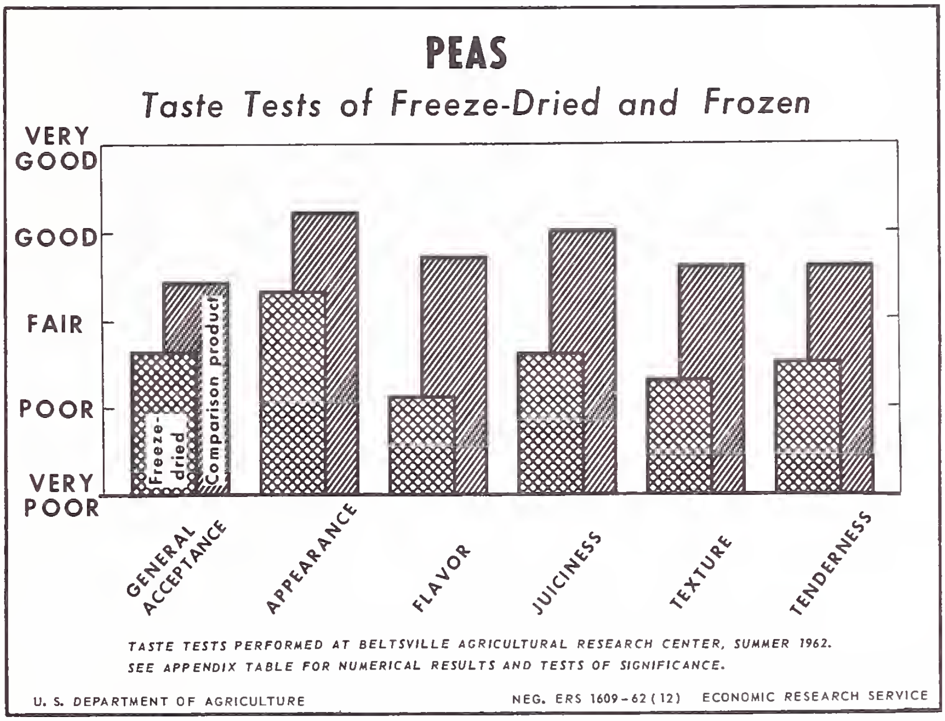


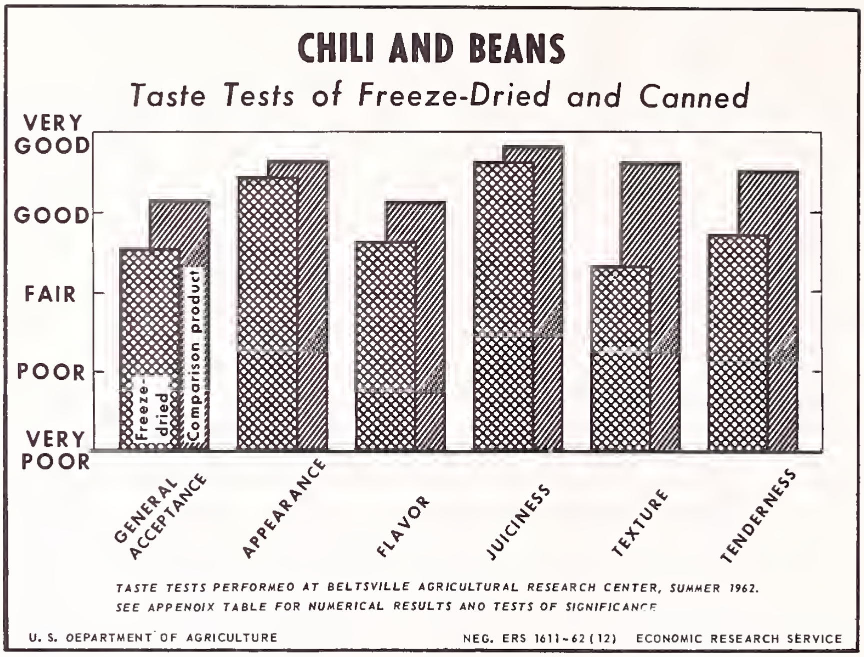
Figure 27

These freeze-dried peas were criticized as "tough," "having tough skins," and being "dry" and "mealy." The frozen peas also were said to have "tough skins" and were judged "dry." Since peas are a perishable raw product, it is possible that adverse criticisms were of a pea quality itself rather than the processing technique used. Also, rehydration directions call for addition of hot water to the product and tests show cold water superior for this purpose. Results from Aberdeen (7) give evidence that cold water should be used in reconstituting nearly all freeze-dried foods. The recommended reconstituting times varied from 5 minutes to 15 minutes, depending on the product in question. Other studies have verified these findings -- that cool or lukewarm water is better for rehydrating freeze-dried products.

Chili With Beans

Mean scores of chili with beans were about the same for the freeze-dried food as for canned in general acceptance, appearance, flavor, and juiciness (fig. 28). However, canned chili was superior to the freeze-dried in texture and tenderness. In spite of not being quite so good as the canned product, the freeze-dried chili had scores ranging from "fair" to "very good."

Freeze-dried chili with beans was commented upon as being "thin and watery," the beans "mushy," the flavor "oniony," and the meat "tough." The canned chili counterpart product was considered to be "too hot in seasoning." The overall appraisal of this product, however, was favorable.



CHILI AND BEANS

Taste Tests of Freeze-Dried and Canned

TASTE TESTS PERFORMED AT BELTSVILLE AGRICULTURAL RESEARCH CENTER, SUMMER 1962.
SEE APPENDIX TABLE FOR NUMERICAL RESULTS AND TESTS OF SIGNIFICANCE

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Figure 28

Summary of Miscellaneous Group

This group of freeze-dried foods had fairly good scores -- the sausage, ham, and chili having about the same palatability level as the comparison foods. Peas, however, were inferior in all characteristics. Eggs were inferior in flavor, and chili inferior in texture and tenderness. Since these products were designed for the camping trade (and sold only in sporting goods stores) they should be appraised with this in mind.

Group Palatability Tests

The general acceptability rating for all the freeze-dried foods analyzed was 3.2 (table 1). A 3.0 score was equivalent to "fair" so the 3.2 mean score indicates panelists considered freeze-dried products between "fair" and "good." Comparison products, as a group, attained a score of 3.7. Our F test shows this .5 difference between group mean scores to be significant. Thus, the group of comparison foods is judged superior in general acceptability to the freeze-dried foods.

In appearance, freeze-dried products received high scores, relative to other palatability characteristics. Their mean score of 3.8 is near the 4.0 score of the comparison products. However, this difference between the two groups is considered significant and we conclude that even in appearance, the comparison standards were better than freeze-dried.

In the two palatability characteristics, flavor and texture, freeze-dried products had a 3.2 average score. Flavor and texture scores of the comparison products were 3.7. In both of these palatability aspects the comparison standards were significantly better than the freeze-dry.

Table 1.--Taste test scores, all products [1]

Palatability characteristics	Mean scores		Difference between mean scores	Difference needed to be significant at a level of 1 percent
	Freeze-dried products	Comparison products		
General acceptability	3.2	3.7	.5	.09
Appearance	3.8	4.0	.2	.09
Flavor	3.2	3.7	.5	.13
Juiciness	3.6	4.1	.5	.09
Texture	3.2	3.7	.5	.09
Tenderness	3.4	4.1	.7	.09

[1] Scores listed are means of 28 products replicated 3 times by 5 panelists. Thus, figures indicated are averages of 330 to 420 taste trials, depending on the number of characteristics rated.

Juiciness scores of freeze-dried foods averaged 3.6 as compared with average juiciness mean scores of 4.1 of the canned and frozen foods. Again, on the average, the comparison items were superior.

Tenderness mean score of all freeze-dried products was 3.4 versus the 4.1 mean score of the comparison foods. Here, also, these comparison scores were superior to freeze-dry scores.

Although the comparison foods were superior, on an overall group mean basis, to freeze-dried products, soups, mixes, and seafoods as groups rated high relative to the comparison foods. In addition, many individual freeze-dried foods scored well. Those that compared favorably in general acceptability include:

Beef steaks
Swiss steak
Beef stew
Creamed chicken
Creamed shrimp
Shrimp creole
Crab
Crab salad
Chili with beans
Beef noodle soup
Mushroom soup, brand A
Mushroom soup, brand B
Chicken noodle soup, brand A
Chicken noodle soup, brand B
Chicken rice soup
Eggs
Sausage
Diced ham

Thus, 18 of the 28 foods were comparable, from a palatability viewpoint, with other standard products. Three including beef noodle soup, chicken noodle soup, and shrimp creole were superior to the comparison foods. Most freeze-dried soups were excellent. Along with seafoods and mixes, soups should be considered as having the greatest palatability potential among the foods tested. Ten were inferior to the comparison foods. None was rated as "unacceptable." Although some products received "low" ratings they may still be considered to have commercial possibilities particularly for specialized uses such as emergency food rations and camping.

Significance to the Food Industry

An overall appraisal of results shows that when a group of freeze-dried foods were rigorously tested in an objective manner by an experienced panel, most of these foods were judged palatable. The question as to whether or not these foods will have market acceptability is the subject of future studies. Nevertheless, the results obtained in this type of study are assumed to be at least indicative of the way consumers may react. Since it is possible to scale the acceptability of freeze-dry products, the results will yield some indication as to the relative market acceptability of these foods. It is recognized that complementary studies, using household or consumer panels, will be required to provide a definitive answer.

In looking at the freeze-drying process and its possible impact on the food industry we might first narrow our area of estimating by asking the following questions:

(1) Which of the freeze-dry groups tested appear to have the greatest future insofar as palatability is concerned?

(2) What palatability limitations are there associated with these foods, and if present, how may they be overcome or minimized?

(3) How might we expect this new industry to affect the canning, freezing, or fresh markets?

Relative to the first posed question, insofar as palatability is concerned, we conclude soups, seafoods, and mixes have a good chance for success in the commercial market. Since many freeze-dried foods are at their best in mixtures, we are led to believe that mixtures need not be prepared in a freeze-dry processing plant. Instead, the plain freeze-dried food might be prepared into a mixture at the point of consumption, as in restaurants and cafeterias. Thus, there may also be a future market for those freeze-dry products that are usable in mixtures.

Flavor seems to be the weakness found most often in freeze-dried foods. Since this study was not designed to determine why some of these foods were poor in flavor, little can be said here about correcting it. Although mixing these foods with other foods which cover taste is one answer, a more satisfactory answer would be to determine why some freeze-dried foods lack flavor.

Our third question was concerning the possible impact of freeze-drying on other food industries. Without doubt there are some processed foods for which freeze-drying will replace the present processing method. An example of this might be in the shrimp industry. Here is an industry where there has been some user dissatisfaction with quality of the frozen product, and it is quite possible if frozen shrimp does not improve in quality and uniformity, that freeze-dried shrimp may replace it to some extent. However, since freeze-dried foods are, for the most part, no better than frozen foods, the frozen food industry will probably not be seriously affected by introduction of freeze-dried foods on the market. The same logic may pertain to the canning industry as well. In the drying field, however, we may expect to see the decline of some heat-drying methods as better quality products supersede. Fresh market sales of many products have been declining for a period of years as more ways are found to handle these products in a processed form. We should expect this trend to continue and may even accelerate as a result of the impact of freeze-drying.

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APPENDIX

Quality Scaling

The type of test used in this study might be described as a discriminative quality scale test. "Single stimuli" rather than paired comparisons were used. By this is meant that each sample was considered individually, that is, without immediate direct reference to any other. This type study differs from the Hedonic scale method which provides a mechanism for measuring "likes and dislikes." However, the same type controls are used and many times the number of points on the scale are similar or identical. For a clear description of the single stimuli test used in this study, see Sensory Testing Methods, a Manual (11) and (5).

The rationale of a quality scale test is based on the assumption that it is possible to develop a concept of general excellence or quality, completely or partially independent of personal preferences. It also assumes that when a person uses this criterion to evaluate foods, personal biases do not affect ratings. Experimental evidence indicates this latter assumption is unwarranted, even with trained panelists. Results on the quality scale do correlate with preference results and this quality scale test is also a preference test (11). To overcome this problem, at least to a degree, our particular study was designed so that adverse preferences could be eliminated. This was done by each panelist indicating known dislikes on the form used for the taste tests. If a panelist's scores were found to differ markedly from the other panelists', the form was checked to ascertain whether the preference box was checked. If such was the case, that panel member's sheet was omitted from further calculations. As it turned out, no adverse preferences were detected.

The tables show numerical mean scores for each food tested. These are simple averages of three replications. In the tables, products are grouped in pairs -- the freeze-dried product and the comparison standard. Each mean score for each product is an average of three replications and each replication score is an average of the five panelists' scores.

The charts and tables bring out the fact that there are variations between products. In three instances the freeze-dried product appears superior to the comparison product. In others, the comparison product appears better. The test of significance gives us a guide as to whether the difference is the result of the processing technique rather than to chance variation.

The palatability judging score sheet is shown in the appendix.

Statistical Tests

Analysis of variance techniques were used to determine whether products prepared with the two processing methods were different from each other, insofar as palatability was concerned. A test of significance (F test) was used to determine whether differences between mean scores of the two products were due to chance variation or to actual discernible differences between products (13, 5).

The outcome of the experiment under discussion is evaluated by comparing the difference between the two mean scores attributable to processing method, with the residual error term measures by the mean square among the replications.

The many considerations regarding this study, discussed in the main body of this report, led us to seek the broadest possible base for establishing error terms to be used in measuring mean differences. First, variations among replications in the freeze-dry and comparison products were computed for each commodity and for each of the six tests -- general acceptability, appearance, flavor, juiciness, texture, and tenderness. Then, following O. L. Davies and others (4) these variances were converted to logarithms and compared in a two-way table (tests x commodities). Among commodities, variances were found to be reasonably homogeneous. Among palatability tests, flavor variance was found to be uniquely high; approximately twice that of the others. The remaining palatability variances, other than flavor, were found to be homogeneous as a group.

The average mean square among replications for flavor was .19286 based on 112 degrees of freedom. The average mean square for all other quality tests was .09866 based on 508 degrees of freedom. Using these mean squares as error terms, the least significant difference test (LSD) between the freeze-dry and comparison products (three replications each) was set at .9 units for flavor and .7 for all other palatability aspects at the 1-percent probability level.

For a more generalized test of differences, all commodities were added together and each palatability characteristic analyzed. The LSD for these tests was .13 for flavor and .09 for each of the others. Here there were 84 degrees of freedom.

In the following tables, 2 to 6, results presented are identical to those in the charts, except that numerical scoring is used in place of descriptive words. A 5 is equivalent to "very good", 4 to "good", 3 to "fair", 2 to "poor", and 1 to "very poor".

Table 2.--Beef: Mean scores of freeze-dried and comparison products

	General Acceptance		Appearance		Flavor		Juiciness		Texture		Tenderness	
	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other
Beef, diced												
Mean scores	2.4	3.3	2.9	3.5	2.7	3.2	2.0	3.8	2.3	3.6	2.3	4.4
Differences	.9		.6		.5		1.8		1.3		2.1	
Beaf, steaks												
Mean scores	2.2	2.8	3.0	3.2	2.1	2.8	2.4	4.0	2.6	3.0	2.4	3.3
Differences	.6		.2		.7		1.6		.4		.9	
Beef, sliced												
Mean scores	2.6	4.0	2.7	4.2	2.8	3.9	2.7	3.7	2.5	4.0	2.5	4.1
Differences	1.4		1.5		1.1		1.0		1.5		1.6	
Swiss Steak												
Mean scores	2.9	3.4	4.0	4.4	3.0	3.4	3.3	3.4	3.2	3.2	3.5	3.7
Differences	.5		.4		.4		.1		0		.2	
Beef Stew												
Mean scores	3.7	3.5	4.3	4.0	3.7	3.7	4.4	4.5	3.6	3.7	3.6	3.7
Differences	.2		.3		0		.1		.1		.1	

The least significant difference (LSD) at the 1-percent level is .9 for flavor and .7 for the other palatability characteristics.

Table 3.--Chicken: Mean scores of freeze-dried and comparison products

	General Acceptance		Appearance		Flavor		Juiciness		Texture		Tenderness	
	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other
Chicken, diced, Brand A												
Mean scores	2.1	3.6	2.8	3.8	2.4	3.5	2.6	3.6	2.3	3.8	2.7	4.1
Differences	1.5		1.0		1.1		1.0		1.5		1.4	
Chicken, diced, Brand B												
Mean scores	2.3	3.6	2.8	3.8	2.4	3.5	2.3	3.6	2.5	3.8	2.2	4.1
Differences	1.3		1.0		1.1		1.3		1.3		1.9	
Chicken Salad												
Mean scores	2.6	3.9	3.6	4.3	2.6	3.9	2.5	4.2	2.6	4.0	2.7	4.4
Differences	1.3		.7		1.3		1.7		1.4		1.7	
Creamed Chicken												
Mean scores	3.3	3.5	3.8	3.6	3.4	3.4	3.0	3.6	3.1	3.3	3.2	3.9
Differences	.2		.2		0		.6		.2		.7	
Chicken Stew												
Mean scores	2.5	4.2	3.8	4.4	2.2	4.2	4.4	4.7	2.4	4.0	3.1	4.3
Differences	1.7		.6		2.0		.3		1.6		1.2	
Chicken Rice Dinner												
Mean scores	2.5	4.3	3.5	4.1	2.3	4.1	3.6	4.3	2.8	4.0	3.2	4.3
Differences	1.8		.6		1.8		.7		1.2		1.1	

The LSD at the 1-percent level is .9 for flavor and .7 for the other palatability characteristics.

Table 4.--Seafoods: Mean scores of freeze-dried and comparison products

	General Acceptance		Appearance		Flavor		Juiciness		Texture		Tenderness	
	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other
Shrimp, plain												
Mean scores	3.0	3.9	4.6	4.2	2.8	4.0	4.1	3.7	3.9	4.4	4.2	4.1
Differences	.9		.4		1.2		.4		.5		.1	
Shrimp Salad												
Mean scores	3.5	4.3	4.5	4.6	3.2	4.4	4.3	4.5	3.9	4.6	4.2	4.6
Differences	.8		.1		1.2		.2		.7		.4	
Creamed Shrimp												
Mean scores	3.8	4.0	4.6	4.0	3.8	3.8	4.0	4.7	4.0	4.1	3.8	4.0
Differences	.2		.6		0		.7		.1		.2	
Shrimp Creole												
Mean scores	4.0	3.2	4.5	3.2	3.7	3.2	4.4	3.2	3.9	3.0	4.2	3.9
Differences	.8		1.3		.5		1.2		.9		.3	
Crab, plain												
Mean scores	3.0	3.6	4.2	3.8	2.9	3.5	4.1	4.1	3.8	3.6	4.0	3.9
Differences	.6		.4		.6		0		.2		.1	
Crab Salad												
Mean scores	3.7	3.7	4.6	4.6	3.4	3.6	4.4	4.5	4.2	4.0	4.4	4.1
Differences	0		0		.2		.1		.2		.3	

The LSD at the 1-percent level is .9 for flavor and .7 for the other palatability characteristics.

Table 5.--Soups: Mean scores of freeze-dried and comparison products

	General Acceptance		Appearance		Flavor	
	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other
Beef Noodle						
Mean scores	3.9	3.2	4.1	3.6	4.2	3.1
Differences	.7		.5		1.1	
Cream of Mushroom, Brand A						
Mean scores	4.6	4.1	4.8	4.4	4.8	4.0
Differences	.5		.4		.8	
Cream of Mushroom, Brand B						
Mean scores	3.5	4.1	3.6	4.4	3.4	4.0
Differences	.6		.8		.6	
Chicken Noodle, Brand A						
Mean scores	4.4	3.6	4.8	4.1	4.4	3.5
Differences	.8		.7		.9	
Chicken Noodle, Brand B						
Mean scores	3.8	3.6	4.1	4.1	3.7	3.5
Differences	.2		0		.2	
Chicken Rice						
Mean scores	3.4	3.4	4.0	3.4	3.7	3.3
Differences	0		.6		.4	

The LSD at the 1-percent level is .9 for flavor and .7 for the other palatability characteristics.

Table 6.--Miscellaneous products: Mean scores of freeze-dried and comparison products

	General Acceptance		Appearance		Flavor		Juiciness		Texture		Tenderness	
	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other	Freeze dried	Other
Eggs, scrambled												
Mean scores	2.9	3.5	3.3	3.3	2.8	3.8	3.8	4.2	3.2	3.7	4.1	4.4
Differences	.6		0		1.0		.4		.5		.3	
Sausage												
Mean scores	3.5	3.7	3.9	3.9	3.8	3.7	3.6	4.3	3.8	3.9	4.3	4.1
Differences	.2		0		.1		.7		.1		.2	
Ham, diced												
Mean scores	3.4	3.5	3.2	3.8	3.5	3.1	3.7	4.1	3.5	3.7	3.3	4.3
Differences	.1		.6		.4		.4		.2		1.0	
Peas												
Mean scores	2.6	3.4	3.3	4.2	2.1	3.7	2.6	4.0	2.3	3.6	2.5	3.6
Differences	.8		.9		1.6		1.4		1.3		1.1	
Chili with Beans												
Mean scores	3.5	4.1	4.4	4.6	3.6	4.1	4.6	4.8	3.3	4.6	3.7	4.7
Differences	.6		.2		.5		.2		1.3		.8	

The LSD at the 1-percent level is .9 for flavor and .7 for the other palatability characteristics.

PALATABILITY JUDGING RECORD

Name ______________________________ Date ____________________

Product ___________________________

Preference for this product:

Please check one before sampling to indicate your usual preference for this product.

	1	2	3	4
Like definitely				
Like mildly				
Neither like nor dislike				
Dislike mildly				
Dislike definitely				

Instructions: Place the number corresponding to the term which best describes the product in the proper column. Write your reasons for your score in the column and space to which they refer.

Sample number				
General acceptability 5 - Very good, enjoyed it very much 4 - Good, enjoyed it 3 - Fair, acceptable 2 - Poor, barely acceptable 1 - Very poor, not acceptable				

Rate the product on the following characteristics using the number score and adjective describing the quality of the product: 5 - very good; 4 - good; 3 - fair; 2 - poor; 1 - very poor. Half points permissible.

Appearance				
Flavor				
Juiciness				
Texture or consistency				
Tenderness				

Comments

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